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INSECTS AFFECTING COFFEE IN PORTO RICO

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Coffee has been cultivated in the island of Porto Rico for some one hundred and fifty years. Previous to the coming of the Americans in 1898, it was the great crop of the island, but within the past fifteen years sugar has forged into first place. The coffee acreage in 1912 was over 168,000 acres; the annual export value (no figures on domestic consumption are available) of the crop for the last five years averaged about $7,000,000. Although coffee ranks second in importance only to sugar cane, little attention has been given to the insect pests affecting it.

In most cases it is extremely difficult to suggest practical means of control for coffee insects. The average plantation has from 700 to 1,000 trees per acre, and the net annual profit per tree averages from two to four cents. In addition, most of the plantations lie in the mountains, and the character of the coffee land is very broken.

The best results in Porto Rico are obtained with coffee grown under shade. Shade trees not only protect the plants from the direct sun, but also conserve the moisture during the dry winter months. The most popular trees for coffee shade are guava (*Inga vera*) and guamá (*I. laurina*). Although these trees often harbor the very destructive "hormiguilla," they also provide almost ideal conditions for the growth of beneficial fungi. For this reason scale insects are almost never of serious importance in coffee plantations.

The literature concerning insects of coffee in Porto Rico is meagre, consisting almost entirely of short notes appearing in various annual reports of the Porto Rico Agricultural Experiment Station subsequent

to 1904. The late Dr. C. W. Hooker began an extended study of coffee insects and this article is a summary of his results and of the writer's observations up to date.

Coffee Leaf Miner

The most generally distributed pest of coffee is the leaf-miner ("minador de la hoja"), *Leucoptera coffeella* Stain. This insect occurs throughout the world in almost every country in which coffee is grown, and was probably brought to Porto Rico when the first coffee plants were introduced. Coffee is the only known host of this insect.

The adult moth is a small, silvery white insect measuring about 2 mm. in length. It is a swift flier, hiding under leaves during the daytime and venturing forth only at night. The length of adult life varies from 1 to 4 days.

The silvery white, flat, oval egg measures about .3 mm. by .2 mm. and has a boat-shaped depression which includes the greater part of its upper surface. It is usually laid on the upper leaf surface and hatches in from 3 to 8 days (average for 107 eggs, 4.7 days). The larva mines the parenchymatous tissue and seriously reduces the functioning area of the leaf, especially when the main veins are crossed. The larval period varies from 7 to 15 days (average for 38 larvæ, 11.4 days). The fully grown larva emerges through a hole in the upper surface of the mine, and after wandering over the leaf a few hours, spins its cocoon, usually on the underside of the leaf. From 3 to 9 days are spent in the pupa (206 pupæ averaged 5.3 days).

Artificial control of the leaf miner has so far been impractical. Nicotine sulphate sprays were partially effective for the larvæ, but failed to kill the eggs. Fertilizing may be a means of remedying the damage done by the miner, for with a stimulation of leaf growth the percentage of leaf area, not functioning because of the miner, will be lowered, for a time at least. The expense of fertilizers in Porto Rico, together with the low market value of coffee, makes fertilizing here a doubtful proposition from an economic viewpoint.

Some varieties of coffee seem to be practically immune to miner injury due to the thickness of their leaves; among these are the Liberian coffee and several other species belonging to the same group. Their product is considered inferior in quality to the common Porto Rican coffee, which is the typical *Coffea arabica*.

There are two fairly effective Chalcids parasitic on the miner in its larval stages. These are *Zagrammosoma multilineata* Ash. and *Chrysocharis livida* Ash. The latter is the more abundant of the two and at times is responsible for at least 30 per cent mortality.

Coffee Leaf Weevil

A weevil ("vaquilla") belonging to the genus *Lachnopus* is of primary importance in many plantations. It is not known to occur at elevations less than 300 meters.

This weevil is most abundant during April and May. It is at this time that the adult does enormous damage by feeding not only upon the leaves, but also upon the blossom buds and the newly set berries which are to produce the crop. The life history study of this insect has so far been unsuccessful in the warm climate of the coast.

Field observations indicate that the weevil has a one-year life cycle. The eggs are laid in flat masses of fifty or more between two overlapped leaves; on hatching, the larvæ enter the ground where they feed on the roots. The greater damage is that caused by the adult. The weevils feed upon *Vitex divaricata* in addition to coffee. A Chalcid has been bred from what appeared to be the egg cluster of this insect. Jarring the trees and hand picking during the months of adult abundance have been recommended, but have not yet been tried on a large scale.

Coffee-Shade Ant

In some districts the most serious pest of coffee is the "hormiguilla," an ant which is primarily a pest of coffee-shade, but too often attacks the coffee trees also. This insect (*Myrmelachista ambigua* Forel subsp. *ramulorum* Wheeler) eats out irregular longitudinal tunnels in which it rears its brood and cultivates colonies of two species of soft scales. When the host tree is coffee, the guest scale is a *Pseudococcus;* in most of the trees shading the coffee the guest is a fleshy, pink scale, representing a new species of *Coccus*. In coffee the tunnels are made in the new growth; this not only lessens the vitality of the plant, but also weakens the branches so that many are broken when the pickers bend them over to gather the berries.

Numerous poisoned baits and sirups have been tried without success. The only method promising relief consists in felling and burning all infested growth, planting temporary shade such as banana, in which the ant will not colonize, and after several months replanting permanent shade trees. By this means a 75-acre area has to all appearances been kept entirely free from the ant for about seven years. This method is very expensive and is of doubtful permanent value, for the danger of reinfestation from without the cleared area is always present.

A small yellow, very vicious ant known as the "albayarde" (*Wasmannia auropunctata* Roger) is reported to occasionally kill and displace colonies of the "hormiguilla." However this ant's pugnacity is

so respected by the pickers that they refuse to enter areas in which the "albayarde" is established.

Minor Pests

Two scales are common on coffee: *Saissetia hemispherica* Targ. and *Howardia biclavis* Coms. The former is the more common. Parasitic fungi hold the scales in check, especially in the case of *S. hemispherica* which is heavily parasitized by *Cephalosporium lecanii* Zim.

Complaints have been received from some localities of a Cossid larva which bores in the main trunk or larger branches of the coffee tree, usually in the upper third. The adult moth has been tentatively determined as *Psychonoctua jamaicensis* Schs. by Dr. H. G. Dyar, who states that it may prove to be a distinct species. The presence of the borer is easily detected by a knotty formation in the old wood. This insect is most often found in old coffee at altitudes up to 1,500 feet. Pruning and burning invaded wood is usually recommended. There has never been a severe outbreak of this pest, to the writer's knowledge; only a few scattering trees at most are attacked.

Another borer occuring in coffee trees is *Apate francisca* Fab. This beetle has a wide variety of host plants in which it makes its longitudinal tunnels for the purpose of egg-laying. The larvæ can develop only in dead wood for they cannot survive the sap flow of living trees. A living coffee tree may have as many as thirteen adults working in its trunk, and still survive, unless broken over by wind. The adults can be killed with a piece of stiff wire.

The spittle insect, *Epicranion championi* Fowl., is fairly common; spittle masses around a berry-cluster often contain as many as six nymphs. Dr. Hooker noted an external Hymenopterous parasite in one instance, but was unable to rear it to the adult stage.

Ormenis pygmæa Fab. is common on the stems of coffee, and has in addition a considerable range of other hosts. It has never been known to injure coffee noticeably. The same statements will hold for the Jassid, *Tettigonia occatoria*.

A mealy-bug (provisionally determined as *Pseudococcus longispinus* Targ. by Dr. Hooker) is sometimes abundant in the berry clusters, concealing itself between the berries.

During the spring an aphid, *Toxoptera aurantii* Boyer (determined by Dr. Edith M. Patch) is extremely abundant on new sprouts of coffee, which it occasionally damages severely. Other hosts of this insect in Porto Rico are orange (which is commonly allowed to grow in a half-wild state amid the coffee) and "geo," an undetermined tree. Dr. Hooker bred an undetermined Chalcid from this insect. For two years the writer has witnessed almost complete control of the aphid

during the late spring in the mountain plantations, by the entomogenous fungus, *Acrostolagmus albus.*

With a few exceptions noted, all of the insects discussed in the above paragraphs were determined by specialists in the Bureau of Entomology.

In addition to the above, there are two species of Maybeetles which attack coffee in the larval stages. The descriptions of these beetles which are probably new and distinct species of Phyllophaga have been drawn up by Mr. E. G. Smyth of Rio Piedras, but have not as yet been published. The larvæ of these beetles are primarily pests of cane, but are also commonly reported as injurious to coffee, particularly to young seedling plants. Two Tachinids have been reared from Phyllophaga adults; one, *Cryptomeigenia aurifacies* Walton, is fairly common; the other, *Eutrixoides jonesii* Walton, is comparatively rare. No other enemies of adults or larvæ have been noted in coffee plantations.

A DEMONSTRATION IN MOSQUITO CONTROL

By C. W. Howard, *University of Minnesota*

Minnesota has always been famous for its mosquitos, and no less in the vicinity of the Twin Cities than in other parts. Screened windows and porches are an absolute necessity for comfort in the summer. Some time ago the president of the Minneapolis Real Estate Board was in New Jersey and in one of the small towns of that state noticed that there were no screens on the windows or porches. Inquiry revealed the fact that mosquitos had been eliminated from the town. He returned to Minneapolis and at once began to plan for an anti-mosquito campaign to be carried out under the supervision of the Real Estate Board until such time as the City Health Department could assume control. The writer was asked by the board to conduct the field work and carry out the campaign except in the matter of publicity and the raising of funds, the University of Minnesota loaning his services for the purpose.

We have no malaria or other mosquito-borne disease in Minnesota, although Anopheles, both *A. maculipennis* and *A. punctipennis*, are present, the latter in considerable numbers in some parts. The campaign was undertaken, therefore, entirely from the standpoint of reducing a troublesome pest.

There are five mosquitos common in the vicinity of the Twin Cities; *Aëdes canadensis, Aëdes sylvestris, Culex pipiens, Culex restuans,* and *Culex tarsalis.* Several other species occur such as *Mansonia per-*

turbans, but these five are the ones which must be mostly considered. Minneapolis is well provided with swamps, and small ponds, which are fast being filled or dredged out by the Park Board so as to be harmless from the mosquito standpoint, but there are many of these still present in the newer parts and in the outskirts of the city. Places which were formerly pot holes full of water are now dry, but dumping is allowed in order to fill them for building purposes. These dumps are full of receptacles which hold water throughout most of the summer and in the cooler months of spring and fall are a prolific source of mosquitos. Sewer catch basins are another matter for consideration, as well as rain barrels, for the women of Minneapolis insist on collecting rain water as the city water is too hard for hair washing.

It was felt that the first season's work must be in the nature of a demonstration if we were to gain support from the public for such a large undertaking as was ultimately contemplated. Accordingly, eight square miles of territory were tentatively chosen in the lake district of South Minneapolis in which conditions were typical for the city and of more than usual difficulty for mosquito control, also where the residents were of a class from which financial support could be obtained.

It would seem that it was an almost impossible task to isolate eight square miles in the center of a city and free it of mosquitos. The area was chosen with this in view. After the preliminary survey more territory was added to the original eight square miles in order to render the results surer, making a total of about ten square miles covered.

It was not possible to get the work inaugurated sufficiently early to catch the first spring brood of *Aëdes canadensis* and *sylvestris*, but the later broods were held in control.

The ten square miles were divided into six districts and an inspector placed in charge of each. A weekly inspection of every yard and premise in the district was made. The season was of such a nature that four sprayings of the swamps were sufficient, the inspectors being taken from their other work and assigned to this work at the proper intervals. The City Park Board agreed to spray all swamps on their property, as did the Great Northern Railway and Lakewood Cemetery which is situated on the southern boundary of the district. The cemetery superintendent also saw to it that all flower vases were emptied once each week. After the first spraying the Park Board ran short of funds and turned the work back to the Real Estate Board. This made our work very heavy for six men, for the swamps in the Lake District are very extensive, one, the remains of an old tamarack swamp, requiring three men a week to cover adequately with oil.

The City Health Board gave their support to the work by granting official badges to the inspectors, so that they were able to enter private premises unmolested. A total of nine inspections were made between June first and September first. With approximately 16,673 premises in the territory covered, this gave a total of 150,000 visits made by the six inspectors. Over 775 rain barrels were found, in spite of the presence of the city water supply, all holding water and breeding mosquitos. Over 335 dumping places were found, one of them, the remains of an old gully, extending nearly three miles across the city. It required some extra labor to keep these dumps mosquito-less, by smashing or burying water collectors. Sewer catch basins numbered 4,272, about 20 per cent of which were defective and mosquito breeders. Each city block averaged about twenty uncovered barrels or ash tins holding tin cans, which were potential mosquito nurseries. From this data it can be seen that the work of the inspectors was not light. Even the dry period coming in late July and August gave no respite, for every small collection of water was found by the mosquitos and the intense heat hastened their development.

In the spraying small D. & B. No. 2 compressed air spray pumps were used, these pumps enabling the operator to control the pressure without removing the tank from his back. We were unable to secure the grade of oil desired, so employed a mixture of heavy fuei oil and kerosene, which gave good results.

In addition to field supervision a biweekly meeting of inspectors was held at which difficulties encountered and plans for the work were talked over. Frequent shifts of inspectors to new districts enabled us to check up on the inspection and make it more thorough.

A leaflet on mosquitos was prepared and printed by the Real Estate Board. A copy was left at every house in the territory and was given to every school child in the city.

Active work was begun on June 1, and by July 1 results began to be very evident in most parts of the eight square miles, and by August 1 few mosquitos were left. We had prophesied that the work would reduce mosquitos 95 per cent, but 99 per cent was a closer approach to the actual reduction. The following letter, printed in the *Minneapolis Daily News* on July 26, is a sample of the opinion which the public passed upon the work.

"*Editor, Daily News.*—When we first moved into our present home, three blocks from the Lake of the Isles, the mosquitos were so bad that we could not weed our gardens in the early evening or sit out with comfort. We actually had to sacrifice our gardening after several seasons of battling with the skeets and we had to screen our porches

at considerable expense or we could not have used them at any time after 6 p. m.

"This summer we have a fine garden and it is a pleasure to work in it because the mosquitos are practically gone. Last evening we sat out on our lawn from 7 to 10 p. m., and in all that time only one lonesome mosquito showed up. We have had our suppers out in our back yard during this hot weather and feel that at last we are getting 100 per cent use of our home investment."

Many citizens remarked to the writer and to the inspectors that for the first time since they had lived in Minneapolis were they able to spend their evenings on lawns and porches without screens and in comfort. Visitors to the Lake Harriet pavilion, close to an area of large mosquito swamps, were able to enjoy the evening concerts with very much less annoyance than usual from mosquitos, although the pavilion was on the extreme limit of our district. Those who indulged in canoeing on Lake of the Isles and Cedar Lake in the evening were also free from the usual pest of mosquitos. One of the best results of the work this past season was the greater attention given to sanitary conditions by the people of South Minneapolis.

As a demonstration of what can be done in the control of mosquitos under city conditions, the campaign was a marked success. It demonstrated what can be done, when the work has been well planned and carefully carried out by good inspectors. Before the summer was very far advanced it was evident that we had chosen one of the most difficult parts of the city in which to carry out the work. The success under such conditions, therefore, shows what could be done over the entire city. A preliminary survey of the city also confirms the opinion that the entire city can be made practically free of mosquitos at small cost, and in addition the reduction of house-flies can be undertaken by the same staff of inspectors. In the eight square miles covered by the inspectors this year, there were found 574 stables, each one with a fly-breeding manure pile, as well as 353 out-door toilets, every one in an unsanitary condition, and a possible source of fly-borne infection.

With both flies and mosquitos under control many sources of disease would be eliminated, not to mention the fact that expensive screens on windows, doors and porches would be no longer needed.

Work ended September 1 as funds were getting short and the demonstration had given sufficiently convincing results.

The City Health Department has tentatively promised to lend financial as well as moral support the coming year. With a large staff and with house-fly elimination added, the brigade of inspectors will become an important adjunct to the City Health Department.

The Real Estate Board undertook the raising of finances for the work by public subscription and met with a hearty response. The cost was as follows:

Salaries for six inspectors, laborers, etc.	$1,133.02
Supplies	157.94
Stationery, postage, leaflets	194.75
	$1,485.71

The newspapers assisted admirably by giving the work the needed publicity. At least every week a story was run by each city paper. The general public also gave their hearty support, only two cases of refusal to comply with our requests occurring. The demand for the continuance of the work seems universal over the city.

WHEN DOES THE COST OF SPRAYING TRUCK CROPS BECOME PROHIBITIVE?

By V. I. Safro, *Louisville, Ky.*

At this time, the item of cost of insect control work is receiving considerable attention. Many entomologists, as well as growers, have had the general impression that when the cost of spraying reaches within an appreciable fraction of the *profit* expected, it becomes prohibitive. They forget that the investment itself represents very often a much larger amount of money than the profit expected.

In the writer's experience, an incident occurred that will be of interest in this connection. In one case it was necessary, for various reasons, to spray a certain patch of thrips-infested onions as many as eleven times in one season, each application costing from $1.50 to $2.50 per acre. Many entomologists would consider this cost entirely prohibitive. However, this procedure was not only not prohibitive, but was an economic necessity.

In the example mentioned, the grower concerned made this statement: "We have already spent our prospective profits; we cannot make any money; but if the spraying is a success, we may break even." When, as was the case, from $150 to $175 per acre has been expended in growing onions and a severe epidemic of onion thrips threatens, it is certainly good business to spend even as much as $50 per acre, if necessary, in spraying to save even as little as $100 of the original investment.

The cost of the spraying of fruit trees for any season, or a series of seasons, cannot be figured as easily on the basis of annual returns as

it can with annual truck crops in which the entire business transaction is completed within the one year. In the case of truck crops, the cost of spraying may be charged to operating expense, whereas it is reasonable to allow at least some of the expense of fruit tree spraying to be charged to increased capitalization, being in much the same category as the éxtension of railroad lines—a charge which is not proper to consider under operating expense.

In the control of pests that attack a wide range of food plants, the usual statement made is that, in the particular field concerned, the results would be only temporary and that in several days the field would again be infested because of the migration of the insects from nearby weeds and cultivated plants. This, in itself, has been considered a prohibitive factor; but under our own observations this is not necessarily true.

As typical of such problems may be mentioned Jassid attacks on beans in the state of Florida. It is quite true that, upon spraying a field, it becomes infested again later on. However, growers have found spraying advisable, the purpose being to keep down a sufficient proportion of the epidemic to permit the plants to become hardier and reach that stage of development that will enable them to withstand a heavy attack of these pests, which, early in the season in untreated fields, have destroyed young, tender plants outright.

An attack of insects on truck crops threatens the definite destruction of part or all of that particular season's business. We have seen hundreds of acres of cantaloupes totally destroyed by aphis, and large plantings of onions rendered unmarketable by thrips. Destructive epidemics of this kind emphasize the necessity of rearranging our ideas concerning the factors that render the cost of spraying prohibitive.

What then should be the true economic attitude on this subject? To formulate a rule covering this problem is, indeed, a difficult matter. The writer, therefore, submits the following suggestion in order that discussion may ensue, as a result of which a definite rule maybe developed which will apply eventually not only to truck crop spraying, but to the spraying of fruit trees as well:

Rule: The cost of spraying truck crops for pests that threaten to destroy all or a large part of the crop does not become prohibitive until the immediate application in view, together with such following farm operations as can be definitely foreseen, have a total cost in excess of the reasonable expectation of gross returns from the crop in question.

It is true that there will be many cases of applications, the necessity for which cannot be definitely foreseen, with the result that at the end of the season it will have been ascertained that the cost of spraying

during the entire season actually did exceed the gross receipts from the crop. Nevertheless, the rule should still hold. As soon as an application has been made, the cost should immediately be charged up to the investment; we can, therefore, very readily imagine a condition that would finally result in a large amount of money being paid out in the *late* part of the growing season in order to recover by such late application all or part of the money previously expended in spraying, as well as other farm operations, carried on in the *earlier* part of the season.

The rule specifies, "Pests that threaten to destroy all or a large part of the crop." What, then, shall be the attitude of the grower in a case of uncertainty as to whether the destruction of all or a large part of the crop is actually threatened?

It seems to the writer that the grower should not give himself the benefit of any doubt. If there is a doubt at all, then he should play safe by considering the destruction as actually threatened.

In this same category the writer would place the problem of parasitism. Parasites may possibly appear in sufficient numbers to afford such an effective control as to render spraying unnecessary, provided the epidemic of parasites could have been definitely foreseen. Unless, however, such parasitism can be definitely foreseen, then the attitude of the grower must be that of the business man in respect to fire insurance, who, knowing that the chances of his business being destroyed by fire are less than one in one hundred, nevertheless carries insurance against such a contingency as a business necessity.

It will be noted that we have said nothing regarding the market, and the writer has done this advisedly. Whether the market price be high or low does not affect the need of getting the greatest amount of product and the highest grade possible; in fact, when the market price is low, there is all the more reason that the *individual* grower turn out the best crop he can. But the essential point is that, even in cases where the market price may fall below the freight charges, this is a contingency that the grower can very rarely foresee at the time he must deal with his spraying problems; and, therefore, the possible course of the market in the future should not affect his efforts or expenditures in taking care of his crop after he has incurred the expense of planting it.

A DEVICE FOR SOWING GRASSHOPPER POISON

By T. H. Parks, *Kansas State Agricultural College*

The seeder shown in the accompanying photograph was improvised, during a grasshopper campaign last summer in western Kansas, to off-set the labor necessary in applying poison bran mash over many acres of land. This seeder was used extensively in Sherman and Thomas counties, and proved to be a success, one man covering as much ground with it as three men sowing the mixture by hand. It was constructed after the manner of an alfalfa seeder occasionally used in that section of Kansas, the dimensions being enlarged to meet the needs of the bran mash.

The seeder consists of a canvas bag which is strapped over the shoulder of the operator and fitted with a feeding device consisting of a canvas sleeve and swinging tube made of tin or galvanized iron, as shown in the photograph. The first one was made on the Kuhrt farm in Sherman County, Kansas, and constructed from an old grain sack, and two empty molasses cans cut and soldered to make the tube.

Some disappointment was encountered before a seeder of the right dimensions was constructed and, after experimenting, it was found that the machine shown in the photograph not only scattered the mixture properly and evenly but covered the ground very rapidly. The dimensions of the metal tube are as follows: Length, 28 inches; diameter at upper end, $2\frac{1}{2}$ inches; diameter at lower end, $1\frac{5}{8}$ inches. Over the opening at the lower end is soldered two short wires bent around in the shape of a U, and crossing each other at right angles at exactly the center and about one inch below the opening of the tube. These wires are soldered to the edge of the tube and soldered together where they cross. Their purpose is to scatter the mixture evenly and thinly as it leaves the tube, being swung by the operator. The canvas sleeve is 12 inches long, 13 inches in circumference at the upper end and 8 inches at the lower end, which fits tightly over the upper end of the metal tube. These were found to be the proper dimensions to allow the mixture to work down into the tube, and to allow the tube to be swung over an 180 degree angle by the operator walking through the field. On a still day the poison bran mash was scattered in this way, evenly and thinly, over a strip of ground sixty feet wide. This enabled one to cover the infested fields in a short time and do the work very thoroughly.

It was found that a seeder made after the above dimensions scattered the poison bran mash at the rate of twenty pounds to four acres, which is recognized as the proper amount to apply under Kansas con-

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1 Scene of the grasshopper poisoning in western Kansas; *2* Poison bran mash seeder in operation; *3* Close view of seeder.

ditions. The mixture can be sown thick or thin depending upon how rapidly the operator travels through the field. Where grasshoppers were found to be very numerous, by walking slowly and whirling the tube regularly the mixture was scattered much thicker than where they were found to be less numerous and the operator walked at a natural gait.

It is necessary to have the oranges or lemons ground through a food grinder in order to prevent the tube from becoming stopped up by the peelings. Many farmers in these counties used old grain sacks cut in two at the middle and strapped over their shoulders in the manner shown in the photograph. One objection to using a grain sack for the bag is that the sweetened mixture penetrates through the cloth and soils the clothes of the man operating the seeder. The writer prepared a bag made of water-proof canvas which overcame this difficulty. Hardware dealers generously supplied the galvanized or tin tubes at the cost of the material plus labor, and sold them at forty cents each. The rest of the outfit was made in a few minutes at the farms. Where it was scattered with these seeders, the grasshoppers ate all of the posioned bait in a few hours and every particle of the poisoned bran was utilized. Owing to their cannibalistic habits, many grasshoppers apparently died from eating the dead bodies of their less fortunate brothers. It was estimated that 75 to 90 per cent of the grasshoppers were killed by one application of the poison bran mash, scattered by means of these seeders. Public demonstrations were given in each township in Thomas County, and the general opinion as expressed by the farmers was that this cheap and simple device made it possible for them to scatter the poison bran mixture over a much greater acreage than they had heretofore attempted. This type of seeder is recommended by the writer to any who may be supervising grasshopper campaigns in the future.

NEW PARASITE CAGES

By C. E. Pemberton and H. F. Willard, *U. S. Bureau of Entomology, Honolulu, T. H.*

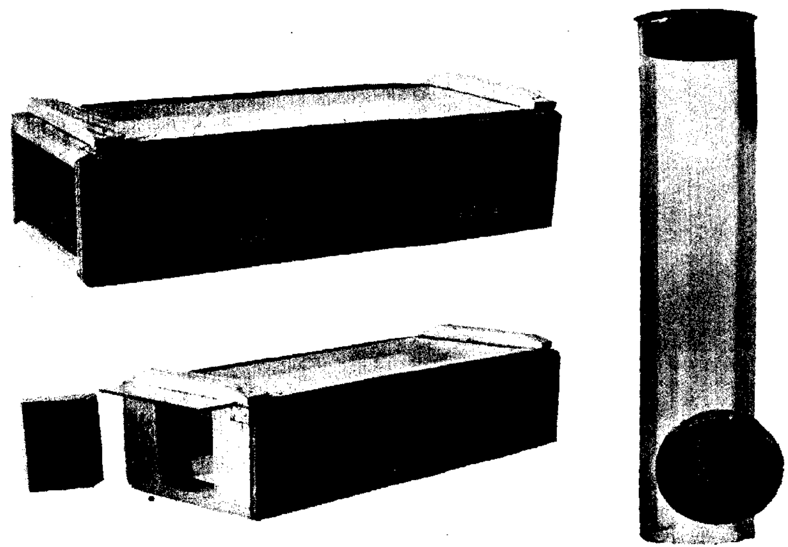
During recent studies of introduced *Braconid* parasites of the Mediterranean fruit-fly (*Ceratitis capitata*) in Hawaii, the adoption of certain improved cages for confining the parasites has given such satisfactory results that it is considered important to place on record a description of these cages.

A glass tube, jar or chimney, in one form or another, with one or more openings tightly plugged or covered, has been usually used by

entomologists for confining living parasites. Of these, the plain test-tube, in several sizes, or the larger sterilizing tube, have been most commonly used. These will always be necessary and for many purposes of great value. However, a free circulation of air through such cages is never possible. In some respects this is an abnormal condition for the enclosed parasites. For general breeding purposes with parasites of the fruit-fly, where moist and often decaying fruit must be placed with them, the elimination of gases from decaying fruit and the prevention of moisture-condensation on the sides of the cage is of the utmost importance.

The main principle involved in the construction of the types of cages herein described is simply one of free-air circulation. Pl. 25, fig. 1 shows the style of cage now in use by the writers. It is invaluable as a cage for the *Braconid* parasites now under investigation. A year's trial has proved its merits over all others for most purposes in general parasite work. It is of simple construction, inexpensive and easily made by hand. The bottom and one end are of wood, both sides and one end are of fine copper screen and the top is of glass which is fitted to slide free from the cage when necessary for cleaning, as shown in Pl. 25, fig. 2 where the glass top has been partially drawn out. In the wooden end a small opening or door is cut. The construction of the door, as illustrated in Pl. 25, fig. 2, has been found most satisfactory. It is sawed from the piece composing the end of the cage, by two oblique cuts. The cut sides of the door are then padded by covering with thin strips of cardboard tightly glued on. This door then fits snugly into the opening, is tighter than a hinged door and more easily made. The glass top is important. This permits easy observation of the parasites within, even with a binocular microscope when desired, and seems also of value in allowing necessary light to enter. The cages now in use are 7 by 3 by 2 inches in size.

The three species of *Braconid* parasites of the fruit-fly now established in Hawaii have been very successfully handled in this type of cage. Oviposition and feeding is quite normal. Individual lots of parasites have been kept in such cages for nearly two months without need, at any time, for cleaning the cages and without any attention being given them other than the daily removing and replacing of leaves containing drops of honey and water for food. By using such cages a great amount of time is thus saved when large numbers of parasites are being handled. Parasites confined in glass test-tubes must be removed to clean tubes every two or three days. This is a slow and laborious process when large numbers must be transferred. "Sweating" in the glass test-tube containing parasites is a great annoyance and often hastens mortality unless constant attention is given the tubes. This never occurs in the



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1 Copper screened box cage; *2* Copper screened box cage. Showing construction of door and method of removing the glass top; *3* Open glass tube cage. Both ends are open and are closed by copper screened caps.

screened box cage, even when a moderate quantity of moist or decaying fruit is placed with the parasites for a day or more.

A second type of cage, illustrated in Pl. 25, fig. 3, has been found useful and is, in some ways, also superior to the glass tube open at one end and plugged with cotton. This is a straight glass tube, 1 to 1½ inches in diameter and 6 to 9 inches long. It is open at both ends. Copper screened caps fit into the ends and are made just large enough to fit into place tightly. This tube also permits free air circulation within. It is of particular value as a container for individual parasites from which oviposition, or other data, is being determined. In such cases food and fruit, or other material, may be placed almost in contact with the parasite without danger of gases of fermentation accumulating and killing or injuring the individual from which valuable records may already have been secured.

Such cages as here described are of importance only in confining parasites considerably larger than the mesh of the copper screening used. The shape of the cage is not entirely essential, the free circulation of the air and abundant lighting being the important points.

These improved cages are most useful in a study of the active life functions of parasites. When it is desired simply to prolong or preserve the life of parasites, the closed test-tube or larger closed sterilizing tube is possibly better. The parasites are then best preserved and the energies least expended when given but little food and kept constantly in partial darkness.

THE BIOLOGY OF CŒLINIDEA MEROMYZÆ (FORBES)

By E. O. G. Kelly, *Entomological Assistant, Branch of Cereal and Forage Insect Investigations*

References to this parasite in literature are very few. It was discovered by Dr. S. A. Forbes in 1883, having been reared by him from the pupa of *Meromyza americana* at Cuba, Ill., April 25, 1883. Dr. Forbes described the parasite in his thirteenth report of the state entomologist of Illinois, as *Cœlinius meromyzæ*, stating that "the abundance of these parasites in this field may be inferred from the fact that out of fifty-five larvæ obtained here, only twenty-one developed the fly (Meromyza), and the thirty-four remaining all gave origin to Cœlinius (Cœlinidea) which continued to emerge from May 6 to May 19. Sweepings of these infested fields in April yielded none of this species, [illegible] can be no doubt that the eggs are deposited within the bodies [illegible] larvæ in autumn."

Dr. For[illegible] conclusion was quite the natural one. No one at that

time would have thought to look for a parasite ovipositing into the egg, knowing the adult issued from a pupa. The comparatively large size of the parasite precluded such an idea. However, within the last few years, several entomologists have made such observations, and there are now on record about a half dozen species of parasites which have this method of oviposition in the egg, with the subsequent emergence of the adult parasite from larva or pupa of its host.

This parasite was again noted in 1891 in Insect Life, as having been found at Ames, Iowa, by Prof. Herbert Osborn, where it preyed upon *Meromyza americana* so abundantly that the injurious multiplication of the host was not feared. It was reported from Canada a year later in *Report No. 22 of the Entomological Society of Ontario*, by Dr. C. J. S. Bethune. In a letter dated April 11, 1916, addressed to the writer, Mr. A. B. Gahan, of the U. S. Bureau of Entomology, states that he has determined the species from a number of localities in the United States. *Meromyza americana* has been recorded from nearly every state in the Union, and this parasite evidently occurs wherever its host occurs. The parasite has been recorded from Canada to Texas, and specimens in the United States National Museum, together with the records in the Cereal and Forage Branch of the Bureau of Entomology, indicate that it is widely distributed in the United States, east of the Rocky Mountains.

The generic name, Cœlinidea, was proposed by Viereck, *Proceedings U. S. National Museum,* Vol. 44, page 555, for Cœlinius (Nees) of authors.

While observing the habits of *Meromyza americana* in the fall of 1908, the writer observed, on September 22, a small Hymenopteron ovipositing into the long white eggs of the Meromyza. A note made by the writer at that time, which has since been on file in the office of Cereal and Forage Insect Investigations of the Bureau of Entomology, states that a small Hymenopteron was observed in the act of ovipositing into the long white eggs of *Meromyza americana,* which were on the leaves and stems of wheat plants. She thrust her abdomen forward between her hind legs, beneath her body, very similar to the position taken by *Aphidius testaceipes,* while ovipositing, and with a sharp, quick jab, struck the white egg. This species was again observed ovipositing on October 2, 1908.

The parasites thus ovipositing into the Meromyza eggs were collected for further study and identification, and were submitted the following winter to Mr. J. C. Crawford for determination. However, Mr. Crawford was not in position to identify them at that time, and therefore they were put away for future reference. They were recently determined by Mr. A. B. Gahan as *Cœlinidea meromyzæ* Forbes.

The Meromyza eggs into which these parasites oviposited were collected and placed in a large vial, where they were kept with especial care until the following spring, but no parasites issued from the eggs, and upon careful examination they were found to be mere shells.

At the time the oviposition was first observed, the relative size of the parasite and the egg was carefully considered, and the writer wondered how such a large parasite could mature in so small an egg, it being fully four times as large. However, the following spring, the writer observed *Diplazon lætatorius* Forb. ovipositing in a similar manner into the eggs of a Syrphid, which had been placed among a number of aphids, on the stems and leaves of a chrysanthemum. The Syrphid eggs were collected for observation. They soon hatched into tiny Syrphid larvæ, which were supplied with aphids for food; they matured as larvæ, and pupated, but instead of a Syrphid adult from the Syrphid pupa there issued an adult of *Diplazon lætatorius* (JOUR. ECON. ENT., v. 7). The writer was then convinced that his observations the preceding fall on *Cœlinidea meromyzæ* were correct, but that improper methods had been used in an effort to rear the parasite. The Meromyza eggs should have been permitted to hatch and mature on the wheat plant.

Since the first observation in 1908, this parasite was not again observed until the fall of 1914, although diligent search had been made for it in the fields, and a large number of Meromyza larvæ had been collected and reared to maturity in an attempt to rear the parasite.

During the summer and fall of 1914 a large number of wheat plants were secured from different localities in Iowa, Missouri, Illinois, Arkansas, South Dakota, Oklahoma, Kansas, and Nebraska. Many of these wheat plants were infested with *Meromyza americana* Fitch. Upon receipt of this material at the laboratory it was placed in breeding cages, each consisting of a large tin can with a small hole punched in one side near the top into which a glass vial was inserted for the purpose of obtaining the mature Meromyza and parasites as they issued. The infested wheat plants which were placed in the warm room of the laboratory produced adults of *Meromyza americana* late in the winter, and soon after these began to issue the parasite *Cœlinidea meromyzæ* began to issue from the same material. Upon comparing these parasites with those collected in September, 1908, they were found to be identical.

Now that the writer was convinced that he had observed this parasite ovipositing into the eggs of *Meromyza americana* in the fall of 1908, he at once set about to rear the parasite in the laboratory. Fortunately a number of Meromyza adults were issuing in early February, in the laboratory, and they were at once placed on potted wheat plants, under

cover. When they had deposited a number of eggs on the plants, several of the parasites were introduced; they immediately began ovipositing into the eggs of the Meromyza, readily verifying the observation of 1908. The interesting method of oviposition was witnessed at this time by Messrs. Packard, Larrimer, and Wade, who were working with the writer at the Wellington (Kan.) laboratory. These men, together with the writer, watched the development of the host and the parasite. It required only a few days for the Meromyza eggs to hatch. The host larvæ matured and reached the pupal stage in about ten weeks, and in about twelve weeks the adults of both host and parasite matured. Further observation in the field and laboratory indicated that the adults of the host and parasite matured about the same time. This, of course, would be necessary in the life economy of the parasite.

In comparing the size of the host and parasite, it was found by Mr. Larrimer that the egg of *Meromyza americana* averages about 1.12 mm. in length, and .28 mm. in diameter, while the Cœlinidea egg measures on an average about .18 mm. in length and .04 mm. in diameter; the *Meromyza americana* egg being seven times larger than the Cœlinidea egg. The Cœlinidea eggs were dissected from the eggs of the Meromyza. The egg is watery white, oblong, with oval ends, very similar in shape to the Meromyza egg.

The adult parasites were introduced into the cage containing the Meromyza eggs, on the 10th of February, and they began ovipositing into the eggs at once, apparently not missing an egg. The Meromyza eggs began to hatch on the 12th of February, continuing to hatch for the next few days. The larvæ did not develop very rapidly, and were yet quite small on the 10th of March. On this date a number of them were measured, the average being about 2.66 mm. in length and .36 mm. in diameter. These larvæ were then dissected and Cœlinidea larvæ removed from them, which larvæ measured on an average .64 mm. in length and .19 mm. in diameter. The Cœlinidea larvæ were in the fatty tissues of the Meromyza, and apparently were not disturbing the alimentary tract, thus not interfering with the development of the Meromyza larva.

Dissecting the Meromyza larva in search of the Cœlinidea larva was rather disastrous to the latter. However, a few were successfully dissected, and it was assumed from the data thus obtained that the Cœlinidea egg hatches very shortly after the egg of the Meromyza, and the two larvæ develop along together, the Cœlinidea larva not maturing until after the Meromyza pupates.

According to further observations in the laboratory by Messrs.

Packard, Larrimer, and the writer, it was found that the larva feeds greedily during the week or two following the pupation of the Meromyza until it consumes the juices of the Meromyza larva within the pupal case, where it also pupates later. The pupal stage of Cœlinidea is very short in the laboratory, being not more than eight or ten days. However, in the field, observations indicate that the pupal stage may be longer.

Observations in the field during the spring of 1915 indicated that the adult parasites were abroad at the same time as the Meromyza adults, and they readily oviposited into the eggs of the Meromyza in the field. Collections of Meromyza larvæ made in May and June gave up the parasites in about twelve to fifteen weeks after oviposition was observed, some of the parasites, however, remaining in the plants until fall. During early September, Meromyza adults were quite plentiful, depositing a large number of eggs on the wheat plants. But it was not until the latter part of September that *Cœlinidea meromyzæ* were observed, and then in large numbers depositing eggs into the Meromyza eggs which were just about ready to hatch. Some of the infested wheat plants collected in November were placed in a warm room at the laboratory and from these issued adult Meromyza and a number of adult parasites in January, 1916. A lot of plants collected at the same place were left in outdoor cages, but from these the host and parasites did not issue until the middle of April.

The indications are that there are two annual broods of the parasite. However, this may vary, because there are some indications that there are more than two broods of the host. It appears probable that if weather conditions are right, and the Meromyza puts out an extra brood, there will be an extra brood of the parasite. From a number of infested plants collected in 1914 and 1915, the percentage of parasitism was apparently not sufficient to be a controlling influence on the host. However, Dr. Forbes and Professor Osborn state that this parasite is evidently a controlling parasite of the wheat bulb-worm in Illinois and Iowa. This may be universally true, because in localities observed there has not yet been a really serious outbreak of *Meromyza americana*, though it frequently does more or less damage to wheat.

THE EFFECT OF CERTAIN CHEMICALS UPON OVIPOSITION IN THE HOUSE-FLY (MUSCA DOMESTICA L.)[1]

By S. E. Crumb and S. C. Lyon

During the summer of 1916 the writers conducted a series of experiments with house-flies to learn, if possible, what substances in horse manure were capable of inciting them to oviposit. In the course of these experiments it was learned that the ether extract possessed this quality in some degree but that the chief incitant remained after complete ether extraction and was a product of fermentation. Further investigation gave positive evidence that this oviposition stimulant was carbon dioxide. A limited series of experiments with ammonia gave negative results.

As the conclusions to be drawn from our experiments did not agree with those of Mr. Richardson[2] it was decided to devise an apparatus for more thoroughly testing the effect of ammonia on fly oviposition and the experiments both with ammonia and carbon dioxide have been continued during the present summer.

The ammonia-testing apparatus (see Fig. 27) consists of a water tank of galvanized iron 7 feet long, 6 inches wide, and 9 inches high set on six legs about 3 feet high and provided with nipples every foot along the bottom. Each of these nipples is connected by tubing with a six-quart can which rests on the table beneath the tank and may be called the compression chamber. This compression chamber is further connected with a pint milk bottle by means of a glass tube which dips beneath the surface of the liquid in the bottle. This bottle rests on the table in front of the compression chamber and contains the ammonia or water used in the experiments. The exit from the milk bottle is through an upright glass tube bearing at its apex a porcelain drying funnel about three and one-half inches in diameter. This funnel has a fixed perforated, porcelain partition about one inch below the lip which bears the material provided as a nidus.

The flow of water from the tank to the compression chamber is regulated to any desired amount by adjustable clamps on the connecting rubber tubes and, as all connections in the apparatus are air-tight, an amount of water admitted to the compression chamber displaces an equal amount of air through the material in the funnel after it has

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[1] Published by permission of the Chief of the Bureau of Entomology.

[2] Charles H. Richardson. The Response of the House-Fly to Ammonia and Other Substances. Bull. 292, New Jersey Ag. Ex. Sta., Feb. 1, 1916. A Chemotropic Response of the House-Fly (Musca domestica L.). Science, new series, vol. 43, 613, April 28, 1916.

bubbled through the liquid in the bottle where the rate of flow is indicated by the number of bubbles produced per minute.

In selecting a material through which to percolate the odors to be tested, it was necessary to obtain something having a texture satisfactory to the ovipositing fly but which did not possess further inciting qualities. After testing asbestos, absorbent cotton, abraded blotting paper, ground chaff, animal charcoal, wheat bran and some other substances, the bran was selected as most nearly fulfilling these conditions. A special grade of this material was obtained which was nearly pure husk. This was thoroughly washed and dried in the sun and before use was moistened, packed in the funnels, and sterilized by steam for an hour or more. The use of this bran did not entirely eliminate eggs in the checks probably for the reason that the texture of the medium may be a secondary stimulant to oviposition.

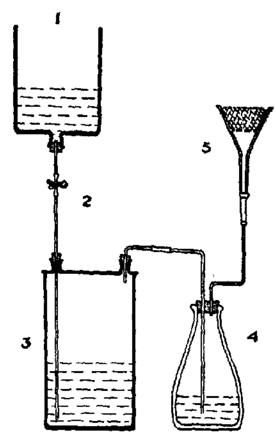

Fig. 27. Cross section of one unit of apparatus for testing the effect of ammonia on house-fly oviposition: 1, Cross section of water tank; 2, connecting tube between water tank and compression chamber. In use the spring clip was replaced by a tubing clamp for regulating the rate of flow of the water; 3, compression chamber; 4, milk bottle containing liquid to be tested; 5, porcelain funnel bearing wheat bran on the perforated porcelain partition.

Each unit of the apparatus for testing carbon dioxide consists of a milk bottle equipped as in the ammonia apparatus (see Fig. 27) excepting that the connecting tube from the compression chamber in the ammonia apparatus is replaced by a dripping funnel having a ground-glass stopper. The bottle was charged with pure carbonate in a little water and the dripping funnel with pure sulfuric acid diluted one to four. When the apparatus was in operation, the acid was allowed to drip into the bottle at such a rate that a continuous slow generation of carbon dioxide resulted. Calcium carbonate was used in the bottle to some extent but the sodium compound was found more satisfactory and was the carbonate chiefly employed. In interpreting the results of the experiments it should be borne in mind that the products of the reaction between the carbonate and sulfuric acid are a sulfate and carbon dioxide and that the sulfate in both cases is non-volatile at ordinary temperatures.

The flies used in the experiments were caught in fly traps and liberated in a cage 6 x 6 x 21 feet square in which the apparatus was set up on a level table. This cage had the roof and one side solid while the ends and west side were of wire screen. Flies of various species were liberated in the cage but all of the eggs obtained in the course of the investigation were placed in a breeding chamber and the house-fly was the only species obtained from the large number of flies bred.

The tests were run from about 10.30 in the morning until 4.00 in the afternoon and at the close of the exposure the funnels were removed and the number of eggs in each recorded. The flies distributed themselves about equally upon the series of funnels and exhibited no noticeable tendency to congregate especially at any of the odors tested. Only in the case of the strongest dosages of ammonia was there a distinct repellent effect after the experiment had been run for several hours.

In the following tables the results of our experiments are summarized:

TABLE 1.—COMPARISON OF RESULTS OBTAINED WITH CARBON DIOXIDE AND AIR

Chemicals	Inclusive Dates	Number Days Run	Total Eggs	Number of Units	Average Number Eggs per Unit	Per Cent of Total Unit Average
Carbon dioxide	6:20 to 7:10, '17	11	5,144	47	109.4	
Air (no current)	6:20 to 7:10, '17	11	291	32	9.1	
Carbon dioxide	8:2 to 8:9, '17	7	3,737	28	133.4	
Air (with current)	8:2 to 8:9, '17	7	294	28	10.5	
Totals:						
Carbon dioxide			8,881	75	118.4	92.4
Air			585	60	9.7	7.6

The above series of experiments consists of two divisions, as indicated, in one of which the conditions in the two sets of apparatus were duplicated, air being forced through the bran in the checks after bubbling through water, while in the other no current of air was provided for the checks to correspond with the gentle current produced by the evolution of carbon dioxide. There was also another difference in the two divisions. In the first the two sets of units were intermingled and set only from 4 to 6 inches apart while in the other the checks were grouped at one end of the series so as to reduce the possibility of their being influenced by the proximity of the funnels evolving carbon dioxide. It will be noted that the checks intermingled closely with the carbon-dioxide units and emitting air at the rate of from 10 to 250 bubbles per minute yielded practically the same average number of eggs as those checks which were isolated and without air current.

TABLE 2.—COMPARISON OF THE RESULTS OBTAINED WITH CARBON DIOXIDE AND AMMONIA

Chemical	Inclusive Dates	Number Days Run	Total Eggs	Number of Units	Average Number Eggs per Unit	Per Cent of Total Unit Average
Carbon dioxide	8:10 to 8:28, '17	9	9,768	27	361.8	91.4
Ammonia	8:10 to 8:28, '17	9	1,320	39	33.8	8.6

The two sets of units in the above experiments were placed from 4 to 6 inches apart in a series and air was bubbled through the ammonia at rates varying in different units from 12 to 240 bubbles per minute. The lower rate gave the bran only a faint ammoniacal odor at the end of the experiment while the higher gave the bran a powerful odor of the gas. The ammonia used was of U. S. P. strength diluted with an equal volume of water, and one hundred cubic centimeters of the liquid were placed in each bottle. The experiments were run the greater part of the time with five ammonia units and three carbon dioxide units equably distributed, thus giving the ammonia the greater opportunity for profiting by chance oviposition. It will be noted that the carbon dioxide received 91.4 per cent of the unit average of the eggs deposited while the ammonia received 8.6 per cent. This ratio is very nearly the same as that shown in Table 1, in which carbon dioxide and air are compared.

TABLE 3.—COMPARISON OF THE RESULTS OBTAINED WITH AMMONIA AND AIR

Chemicals	Inclusive Dates	Number Days Run	Total Eggs	Number of Units	Average Number Eggs per Unit	Per Cent of Total Unit Average
Ammonia	8:29 to 9:8, '17	9	1,170	36	32.5	32.6
Air	8:29 to 9:8, '17	9	2,424	36	67.3	67.4

Eight units divided equally between the ammonia and air were run throughout these experiments. The ammonia was of the strength and quantity used in the previous series and an equal amount of water was placed in the check bottles. The two sets were placed alternately about one foot apart and three of the adjacent pairs of bottles, one containing ammonia and the other water, had air bubbled through the liquid at equal rates, varying in different pairs from 5 bubbles to 250 bubbles per minute, the usual series being about 12, 24, and 180 bubbles per minute respectively. An additional check bottle had no air current and the remaining ammonia had air bubbled through the liquid at some rate intermediate with the above. No oviposition

occurred which could be ascribed to any particular dosage of ammonia though the north end of the series, which was usually occupied by the heavier dosages, produced most eggs both on the ammoniated bran and the checks but when the lighter dosages were shifted to this end the heavy oviposition continued to occur at the north end of the series. The check funnels received 67.4 per cent of the unit-average of the eggs deposited and received decidedly more eggs than the ammoniated units on seven of the nine days the experiments were run.

A careful analysis of Mr. Richardson's experiments leads us to believe that the apparent discrepancy between his results and ours is only in drawing conclusions. Certainly he obtained marked oviposition in no case where carbon dioxide was undoubtedly absent and we believe that this was the oviposition-inciting principle in his investigation as well as in our own.

THE LIFE-HISTORY OF THE OKRA OR MALLOW CATERPILLAR (COSMOPHILA EROSA HÜBNER)

By H. L. Dozier, *University of Florida, Agricultural Experiment Station*

Introduction

The attention of the writer was first called to this insect on July 16, 1916, on passing by an okra field at Gainesville, Fla., and observing badly eaten leaves of the plants. A search quickly revealed the culprit to be the larva of some noctuid.

As I shall mention later in this article, the work of this larva has probably been attributed to that of *Autographa brassicæ*.

Since this insect was of undoubted economic importance, a study of it was begun upon which the present paper is based. All investigations were carried on at Gainesville, Fla.

Dr. Chittenden[1] calls this the Abutilon moth but here in Florida it would seem more appropriate to call it the okra or mallow caterpillar, since it is found on such a large number of the Malvaceæ.

History

The moth was first figured by Hübner (Zeitr. 287, 288) in 1818. It was fully described by Guenée who describes the larva, under the name of Cosmophila, in a few words, giving its food plant as Hibiscus. Comparatively little mention of this species has been made since this time.

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[1] Bulletin No. 126, Bureau of Entomology. This bulletin contains a full bibliography.

Distribution

Cosmophila erosa is principally a southern species and continues breeding the year round with scarcely any intermission. Moths have been captured in various parts of the South from July throughout the winter till May.

Grote gives Savannah, Ga., and Alabama as localities. According to Riley, larvæ of all stages were found in March, 1882, feeding on *Urena lobata* at Crescent City, Fla. They could not be found on any other plants.

The following data from the manuscript of the List of Florida Lepidoptera by the late Mr. Grossbeck were supplied to me by Mr. Frank E. Watson of the American Museum of Natural History: "*Cosmophila erosa* Hbn., Lakeland, May 5, Fort Myers, April 26, La Belle, April 27 (Am. Mus. Nat. Hist.); South Bay, Lake Okeechobee, April 29, 30 (Am. Mus. Nat. Hist., Davis.); Indian River (Am. Mus. Nat. Hist.); Chokoloskee (Barnes); Hogtown Creek, Gainesville, October 1 (F. E. Watson).

"Extends northwards to Massachusetts and Montreal, westward to Kansas and southward through Mexico and the Antilles to South America. Occurs also in South Africa and in the Oriental and Australian regions."

Observations

The writer first found the larvæ of this species doing serious damage to okra plants July 16, 1916, on several separately located plots. The damage in these cases was very noticeable. On this date, the plots were searched carefully and no adult moths were found, only larvæ—for the most part fullgrown, and numbers of pupæ. An okra field examined August 27 showed larvæ and pupæ in abundance.

On August 8, it was noticed that nearly every leaf on numbers of the cotton rose (*Hibiscus mutabilis*) plants on the station grounds was seriously damaged. On this date and on the 15th, the larvæ were very abundant.

Large numbers of pupæ and a few larvæ were collected August 23 on bushes of the flowering maple (*Abutilon striatum*). The work was similar to that done to okra plants but even more serious. The beauty of these bushes as ornamentals was ruined, they being nearly defoliated. Breeding was kept up steadily and, on September 2, eggs and larvæ were collected. Eggs were found in abundance on these plants again on October 14.

The caterpillars were found to have been working on plants of the swamp or rose mallow (*Hibiscus moscheutos*) August 24 and a pupa was found on one of the leaves.

A search of chinese mallow (*Hibiscus sinensis*) plants on the university grounds showed the presence of this caterpillar. Their work on these plants was not very noticeable at this time although a new phase of injury was observed. Numbers of the unopened flower buds were found to be eaten into, the culprit in a number of cases being caught red-handed in the act. The leaves showed the same typical injury, although in this case the young tender foliage seemed to be markedly preferred. Larvæ were found at work upon these plants October 14 and the injury was now decidedly noticeable. This species of Hibiscus seems to be less attacked than any of the others, probably on account of the tougher texture of its leaves. A number of pupæ were found on these plants November 10.

As this species was found to attack other plants of the Malvaceæ, it was thought highly probable that it would be found to attack cotton. Therefore, a careful search was made over a small cotton field where a large number of the different varieties of cotton were being tested. The work of this species was noticed scattered here and there indiscriminately on the different varieties, the insect seeming not to discriminate between any of them. After a careful search, a few caterpillars, pupæ, and empty pupa cases were found. The damage, however, was hardly noticeable and entirely negligible in this case. No other species of caterpillar was found working on the cotton.

This insect was found attacking the roselle (*Hibiscus sabdariffa*) plant at Gainesville, Fla., August 30, and a pupa of the same was sent in September 19 by a correspondent from Kuhleman, Fla., on roselle. It probably occurs all over the state wherever the roselle plant is cultivated.

On September 1, a few plants of roselle growing in the insectary were found to be infested with these caterpillars. Several bell pepper plants growing nearby were also found to contain a number of pupæ and evidence of the work of larvæ. Due to the close proximity of these pepper plants to those of the roselle, their being attacked would seem more or less accidental.

Closely Related and Associated Species

According to Mr. Grossbeck (*loc. cit.*), two or three other species of *Cosmophila* occur in Florida, *Cosmophila xanthindyma* Bd., *C. doctorium* Dyar, and ? *C. texana* Riley (determination doubtful).

Cosmophila larvæ, when on cotton, are often mistaken for those of *Alabama argillacea* but a person familiar with these can readily distinguish between them. The two, however, are very much alike in their early stages. The adult moths do not look like those of *Alabama*.

On plants of the cotton rose, larvæ of *Chloridea virescens* Fabr. were found August 4 in association with those of *Cosmophila*. Together, they were doing serious damage.

Chloridea virescens is known as the true tobacco bud worm moth. The following description will serve to distinguish between these two insects in the different stages:

Chloridea virescens

DESCRIPTION. *Larva:* Smooth, soft, translucent, green in color. Finely speckled with pale yellowish spots, body covered with fine translucent hairs. These fine translucent hairs are lacking in *Cosmophila*.

Pupa: Blunter anal extremities than *Cosmophila* and conical projection on front of head.

Adult: About the same size as *Cosmophila*. Has its front wings light green in color crossed by three light bands. Each band is relieved by a dark greenish shade on its outer border; hind wings silvery white or slightly tipped with dusky markings.

Larvæ feed upon Solanaceous plants; has been reared from *Solanum seiglinge* and *Physalis viscosa*.

Both *Chloridea virescens* and *Cosmophila* are strongly attracted to lights. With them are taken large numbers of another noctuid that greatly resembles *C. virescens*. This is *Shinia trifascia* Hübner and can be distinguished from the latter by its smaller size and slight differences in markings.

Food Plants

Riley states that the food plant of *Cosmophila erosa* is *Urena lobata* and that eggs and larvæ were found in September 1882, on *Abutilon avicenna* at several localities in the District of Columbia. Larvæ and eggs were found on leaves of *Malva rotundifolia* at Giesborough, D. C., October 28, 1916.

Chittenden gives an account of its attacking Abutilon and hollyhocks at Diamond Point, Va., and states that it was found on okra at Washington, D. C., in 1912. He states that the larvæ seem to prefer Abutilon to hollyhock.

The writer has found this insect feeding on the following plants in order of damage done at Gainesville, Fla.: Flowering maple (*Abutilon striatum*), okra (*Hibiscus esculentus*), confederate or cotton rose (*Hibiscus mutabilis*), roselle (*Hibiscus sabdariffa*), Chinese mallow (*Hibiscus sinensis*), cotton (*Gossypium* spp.), swamp or rose mallow (*Hibiscus moscheutos*), and bell pepper (*Pepperomia* sp.).

Economic Importance

The work of *Cosmophila erosa* on okra has doubtless been attributed to that of *Autographa brassicæ*. The former seems to be one of the worst pests of okra.

Roselle is fast becoming an important commercial plant in southern Florida where it is grown for making jelly. *Cosmophila* is capable of becoming a very serious pest to this plant.

As an enemy of ornamentals, such as the different varieties of Hibiscus, Abutilon and hollyhocks, this insect seems to be a serious one, capable of ruining the appearance of the plant in a very short time. Large numbers of Hibiscus plants are grown for commercial purposes in the nurseries of the state and nearly every private home garden contains a few of these plants for decorative purposes.

Although in the case cited, the damage done to varieties of cotton was negligible, this might not always be the case. *Cosmophila* would be capable of doing serious damage to cotton under favorable conditions. Again, work of *Cosmophila* has probably been often attributed to that of the cotton caterpillar, *Alabama argillacea.*

General Habits of the Larvæ

The larvæ, upon hatching, make their first meal of their egg shells. The newly hatched larvæ are almost indistinguishable from those of *Alabama*, being the same in size and color. In this state they are most nervous and active, and are usually found feeding on the lower side of the leaves, which they resemble so much in color that it is difficult to detect them when at rest. They stretch to their fullest extent, when resting, but are often observed in the erect position assumed by Geometrid larvæ.

According to Riley, "the principal time of feeding, as observed in my vivarium, appears to be at night, and the larvæ usually rest during the day on the lower sides of the leaves." According to the writer's observations, the larvæ feed steadily during the day, full-grown larvæ having been observed in the field in September feeding on Hibiscus buds at 10.30 a. m. in bright sunlight. The writer has also observed larvæ in many cases to eat a great deal during the day in his confinement cages. There is no doubt that the larvæ in Florida feed steadily during the day.

The larvæ in the first stage do not skeletonize the leaf in feeding as do many of the Noctuidæ but eat numerous small holes in it. The larger larvæ in feeding eat out large holes in the leaves. In the case of flower buds of Hibiscus the larvæ eat into the buds destroying their contents. This phase of injury has not been observed on any of the other food plants.

The larvæ travel with the characteristic movement of semi-loopers. As they grow larger they become more and more sluggish in their movements, usually clinging very tenaciously to the leaf. The larvæ, when full grown, often assume a very peculiar position—that of a ρ—when at rest upon either the upper or lower surface of the leaf.

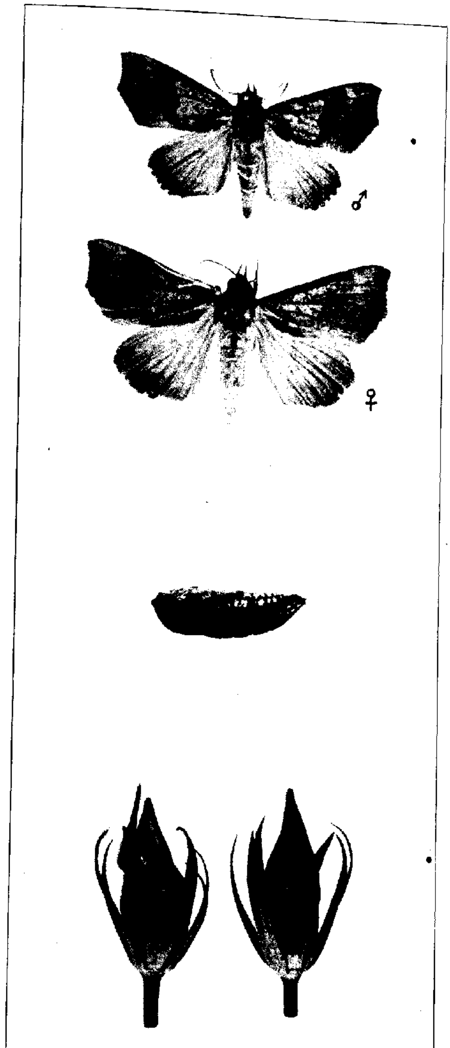

Fig. I. Adult moths x 2. Fig. II. Pupa x 2. Fig. III. Work of larvæ in Hibiscus buds.

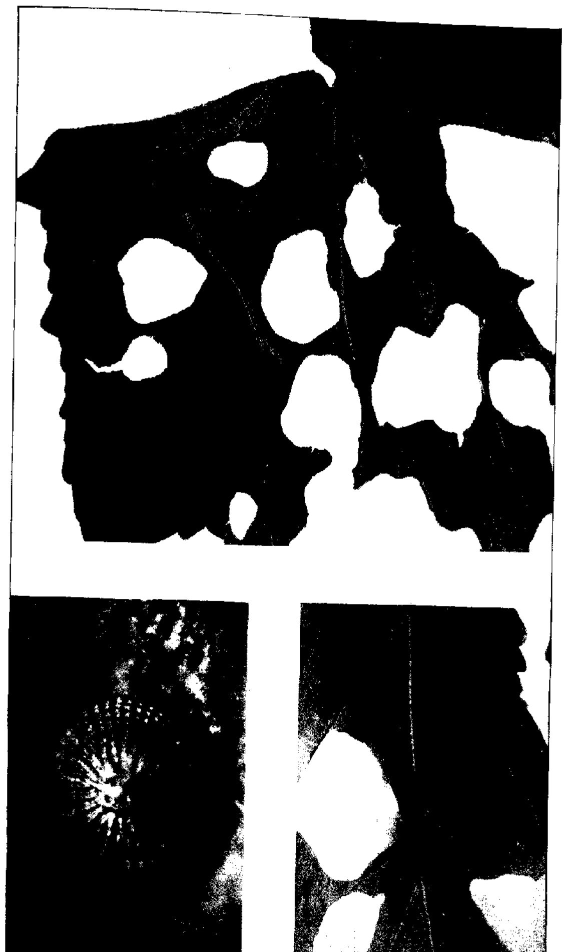

Fig. I. Larva and work on *Hibiscus mutabilis* leaf, showing also edge of leaf folded over to contain pupa. Fig. II. Photomicrograph of egg. Fig. III. Full-grown larva on okra leaf.

GENERAL DESCRIPTION OF STAGES

EGG.—The egg is circular in shape, flat below, with diameter of 0.8 mm. It is ribbed, the ribs running from the base towards the summit, many reaching only half way to the summit. This egg looks a great deal like that of *Alabama* and *Heliothis*, also very much like that of the velvet bean caterpillar (*Anticarsia gemmatilis*), although much smaller in size. The color is almost white, when first deposited, soon turning to a pale yellowish green, almost of the same shade as the lower surface of the leaf.

LARVA.—The newly hatched larva is 2 mm. in length; entire body whitish; head glycerin-like in color, tips of mandibles reddish brown. After the larvæ have eaten, their bodies take on a faint greenish appearance.

According to Riley, there are six moults, making seven instars. The full-grown larva is light green in color, measuring 1⅜ inches in length.

PUPA.—The pupa is 15 mm. in length, blackish-brown in color with opaque wing sheaths, the remaining portion slightly polished. The front of the head is prolonged into a short, stout, conical projection. Riley gives the following description of the tip of the last joint: "The tip of the last joint is broad and prolonged each side into a short, stout, and sharp tooth directed forward. Between these two is a pair of slender, bristle-like spines directed forward and with their tips curved in the shape of a loop; another pair of similar spines, which are directed forward and inward, are situated, one at each side, on a small projection which is armed at its edge with two large, stout, claw-like teeth, which stand at right angle to the body of the pupa."

ADULT.—The male and female of this species differ greatly, the female being slightly the larger in size. The female is a bright orange yellow in color, the forewing slightly speckled with red and with slight purplish suffusion below the postmedial line, and has a wing expanse of one and a quarter inches. The male has its forewings reddish brown in color, suffused with purple gray.

LIFE-HISTORY

Copulation was not observed during the day and probably takes place at night. The eggs are deposited at night, usually, or about dusk, singly on either the upper or lower surfaces of the leaves, the majority being deposited on the under surface. One moth in captivity deposited a scattered mass of 142 eggs on the sides of globe of the cage before dying.

Incubation takes about four days. The newly hatched larvæ, after devouring their eggshells, rest for a short time and then begin to eat the leaf.

The larval stage lasts about twenty-four days. The full-grown larva is very sluggish. It pupates, usually, by simply folding over the edge of the leaf, pupating in the recess thus made. On young okra and Abutilon leaves, it makes its pupation chamber by drawing the edges of the leaf together in such a manner as to leave a little groove in which the pupa lies ensconced. Where two leaves happen to touch or overlap, they are fastened together by a few silken threads, the larva pupating between.

Large numbers of click-beetles of two species, *Monocrepidius lividus* and *M. vespertinus*, are often found in these pupal chambers. What they are doing there is somewhat of a mystery. Experiments seem

to indicate that they act as scavengers. They would not attack living larvæ or pupæ but did in one case eat the remains of a dead pupa that had been eaten into.

The pupal stage averages six days in July. The length of this stage increases as the season advances. During August, this varied greatly, from as short as five days to as long as fourteen days. In October, the average was about nine days.

The adults copulate soon after issuing and the eggs are deposited within a few days. After all her eggs are deposited, the moth has completed the life-cycle and dies, usually within a week after her emergence.

Thus the complete life-cycle requires about thirty-four days.

Natural Enemies

The most important enemies of *Cosmophila* are the different species of wasps that prey upon them. *Polistes americanum* Fabr. was taken in the act of chewing up a full-grown larva in an okra field.

Numbers of a small hymenopteron, *Chalcis ovata*, have emerged from pupæ at different times, although the percentage of parasitization is very small. These always emerge from the upper portion of the pupa. No other internal parasites of the pupæ or larvæ have been reared.

Curious looking larvæ of a small ground beetle, *Callida decora* Fabr.[1] are often seen in the act of attacking and devouring larvæ of *Cosmophila*. These larvæ usually attack the caterpillar by the throat, holding on until it gives up the fight and succumbs. They attack the full-grown larvæ as well as the younger ones and doubtless feed on the eggs as they have been noticed to do in the case of the velvet bean caterpillar.

The larva of this beetle is 7 mm. in length. It takes about a week for the larva to mature. Upon reaching maturity, it pupates just beneath the surface of the ground or beneath leaf-rubbish. The pupa is whitish with dark-brown eyes, the body being covered with fine golden-colored hairs. The pupa stage lasts four days. The adult is a bluish-green carabid and is capable of living a month and a half without food.

Numbers of *Cosmophila* eggs were collected October 16 on leaves of Abutilon. Many of these looked bluish or black in color as if parasitized. On October 20, several minute hymenopterous parasites, *Trichogramma pretiosa* Riley, issued from the eggs.

A pentatomid, *Euthrynchus floridanus*, and a reduviid, *Zelus bilobus*, and other predaceous hemiptera without doubt are important enemies, as are also the insectivorous birds.

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[1] This is an important enemy of the velvet bean caterpillar in Florida. Florida Agr. Expt. Station Bull. 130.

NOTE ON THE LIFE CYCLE OF THE SUGAR-BEET WEBWORM[1]

By H. O. MARSH, *Scientific Assistant, Truck Crop Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

In 1912 the writer published a preliminary report[2] on the sugar-beet webworm (*Loxostege sticticalis*).[3]

At the time that bulletin was prepared the details of the life history and egg-laying habits had not been definitely worked out. During the years 1915 and 1916 a series of more detailed records were obtained and the results are given herewith. The work was carried out in an open-air insectary at Rocky Ford, Col. The insects were confined in glass battery jars and the larvæ were fed with the foliage of sugar beets and lambs quarters (*Chenopodium album*).

TABLE I.—RECORDS OF THE GENERATIONS OF LOXOSTEGE STICTICALIS AT ROCKY FORD, COL., DURING 1915

Item	First Generation	Second Generation	Third Generation
Adults developed	June 9, 1915	July 25, 1915	Sept. 9, 1915
First eggs deposited	June 19, 1915	July 31, 1915	Sept. 16, 1915
First eggs hatched	June 22, 1915	Aug. 4, 1915	Sept. 20, 1915
First larvæ matured	July 8, 1915	Aug. 19, 1915	Oct. 27, 1915
First larvæ pupated	July 12, 1915	Aug. 24, 1915	May 10, 1916
First adults developed	July 25, 1915	Sept. 9, 1915	June 2, 1916
Egg stage, days	3	4	4
Larva stage, days	20	20	233
Pupa stage, days	13	16	23
Total duration	36	40	260

TABLE II.—RECORDS OF THE GENERATIONS OF LOXOSTEGE STICTICALIS AT ROCKY FORD, COL., DURING 1916

Item	First Generation	Second Generation	Third Generation
Adults developed	June 2, 1916	July 14, 1916	Aug. 16, 1916
First eggs deposited	June 14, 1916	July 17, 1916	Aug. 19, 1916
First eggs hatched	June 18, 1916	July 20, 1916	Aug. 24, 1916
First larvæ matured	July 1, 1916	Aug. 2, 1916	Sept. 11, 1916
First larvæ pupated	July 5, 1916	Aug. 7, 1916	May 16, 1917
First adults developed	July 14, 1916	Aug. 16, 1916	June 11, 1917
Egg stage, days	4	3	5
Larva stage, days	17	18	265
Pupa stage, days	9	9	26
Total duration	30	30	296

[1] Published by permission of the Secretary of Agriculture.
[2] The sugar-beet webworm, Bul. 109, pt. VI, pp. 57–70.
[3] Family Pyralidæ, order Lepidoptera.

Under conditions existing in the field, a large number of the larvæ of the second generation did not pupate until May of the following year. The third generation seldom appears in sufficient numbers to cause appreciable damage.

Egg-Laying Records

Egg-laying records were obtained at Rocky Ford, Col., by isolating single pairs of moths immediately after they developed. The moths were fed with the nectar of alfalfa blossoms and the eggs were deposited on sugar-beet leaves which were placed in the cages for the purpose. The eggs were removed and counted daily. The number of eggs deposited by five females of the first and second generations were 153, 263, 377, 435 and 502, or an average of 346 eggs per female.

A detailed record of the female of one of these pairs which developed July 22 is given in Table III.

Table III.—Egg-Laying Record of a Single Female Loxostege sticticalis at Rocky Ford, Col., in 1915

Date	Number of Eggs Deposited
July 29	59
July 30	76
July 31	53
August 1	33
August 2	22
August 3	30
August 4	12
August 5	5
August 6	31
August 7	31
August 8	4
August 9	9
August 10	11
August 13	1
Total	377

The male died August 7 and the female died August 14. The egg-laying period covered a total of sixteen days.

THE HOP REDBUG (PARACALOCORIS HAWLEYI KNIGHT)[1]

By I. Myron Hawley

During the past few years hop plants in the yards about Waterville, N. Y., and especially in the vicinity of Sangerfield, have shown conspicuous injury to the foliage by perforations of the leaves and also by a stunting and deformation of the stems. In June, 1913, there were several yards at Sangerfield notably injured in this manner. Careful examination of the affected plants disclosed the presence of large numbers of red nymphs with white markings. When these yards were examined the first part of July, the nymphs were feeding on the vines and sap was flowing from the wounds which they had made. A few adults were taken at this time, which later were found to belong to the family Miridæ. Because of their striking color the writer has called them the hop redbug. Each year since 1913 the insect has increased greatly in numbers and caused more and more injury. It may now be found in yards ten miles from Sangerfield but does not appear to have reached the Cooperstown district, thirty miles distant.

The writer submitted a large series of specimens for examination to H. H. Knight, who reported them as representing a new species and described it as *Paracalocoris hawleyi*. Later the determination was confirmed by W. L. McAtee, who in addition described several varieties of the species. The drawings of the various stages are by Miss A. C. Stryke.

Nature of the Injury

The injury may be recognized by the deformed and stunted vines (Pl. 28, Fig. 1) and the irregular holes in the leaves (Pl. 28, Fig. 2). The initial injury is made evident by many light spots in the still unfolded leaves. On close examination it is found that the epidermis is broken on the under side. Later, as growth continues, a dead area is produced and, when this drops out, irregular holes result. The early work is found about the middle of June, and by the middle of July the leaves may be completely riddled.

In the later stages a nymph may feed on the vines, causing the sap to flow from the punctures. As the vine grows it will often become stunted on the side attacked, and by continuing its growth on the opposite side, a sharp bend will be formed. A plant is often weakened so that its clinging power is lost. The main stems will tend to hang down and often all the vines of the hill will slip down around the base of the pole (Pl. 28, Fig. 3). The older nymphs may also feed on the burrs

[1] Contribution from Entomological Laboratory of Cornell University.

and hop heads, but serious injury to these parts could not be detected. Pole yards are attacked worse than string yards; in string yards, the vines on the pole show more injury than those on the strings. The work of the hop redbug is similar to that described by F. V. Theobald for a related species, *Calocoris fulvomaculatus* Deg., which has caused some injury to the hop in England.

Life-History

Egg—The egg (Fig. 28) is 1.6 mm. long, .4 mm. wide and .2 mm. thick; dirty white, curved, with two prominent, pure white, incurving hooks on the micropyle end. One hook is pointed and the other is blunt at the tip. The surface of the egg is smooth and glossy.

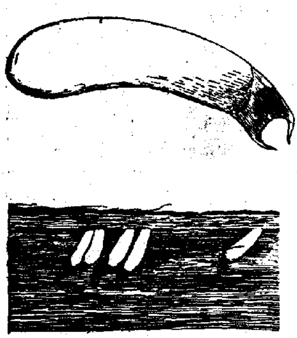

Fig. 28. *Paracalocoris hawleyi*: lower figure, eggs in bark, × 9; upper figure, one egg, more enlarged (original).

The eggs are inserted singly and in groups of two, three or four in the bark or wood of hop poles, to which they are attached by a secretion. In cedar bark the eggs are placed in a slit in the bark transverse to the grain, and can best be seen by tearing the bark lengthwise (Fig. 28). When found in this way, the otherwise inconspicuous white cap may be located on the outside. Only one egg has been found in the hard wood of a pole. This was in a crack just deep enough for the egg. Since nymphs are equally common in the spring on poles of this kind, eggs must be laid there in large numbers. The egg stage lasts from nine to nine and one half months.

Nymph.—*Stage I:* Length, 1.3 mm. (average of 10); general color light tomato red; a median, variable light line runs from near the cephalic end of the head to near the posterior end of the second abdominal segment, faint in some but in others distinctly white, bordered laterally on the thorax by clay colored patches. Antennæ with the basal segment slightly clubbed, tomato red and sparsely clothed with hairs, second segment sparsely hairy, white ($^2/_3$) and red ($^1/_3$), third segment sparsely hairy, white (½) and red (½), fourth segment densely hairy, clay color with small white spot at base. Coxa of leg is white, trochanter white, femur red, tibia with three red and three white bands of varying breadth, tarsus white with dark tip, claws dark. Each abdominal segment bears a row of dark setæ; head and thorax bear irregularly arranged setæ. Beak is white with dark tip. Venter is clay color. In a few cases the median line is wanting as well as all white bands, the insect being red with the exception of 4th antennal segments. The description is for the most typical specimens (Fig. 29).

Stage II: Length, 1.9 mm. General color, slightly darker; median line broader and more distinct; clay colored border patches indistinct; bands on antennæ and legs

Hop redbug work. *1, 2* Injury to leaves; *3*. Hill showing vines slipping down the pole.

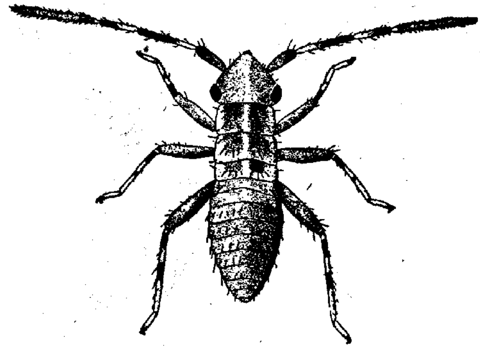

Fig. 29. *Paracalocoris hawleyi*, first stage nymph, × 30 (original).

more prominent; white spots begin to appear around setæ on abdominal segments; basal antennal segment a darker red and much more hairy; terminal segments lighter except at tip. Aberrant specimens show no median line, no white bands, faint bands on antennæ and legs or faint bands on antennæ and none on legs (Fig. 30).

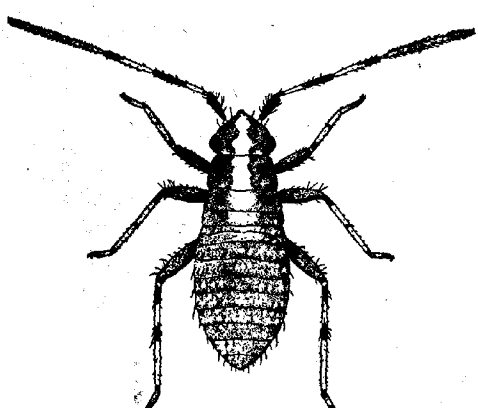

Fig. 30. *Paracalocoris hawleyi*, second stage nymph, × 21 (original).

Stage III: Length 2.5 mm. General color same as previous stage; red bands on antennæ and legs much darker than body. Wing pads begin to show; white spots around setæ more distinct. Setæ longer and coarser. Some aberrant specimens as before (Fig. 31).

Stage IV: Length 3.1 mm. General color as before. Wing pads brownish and

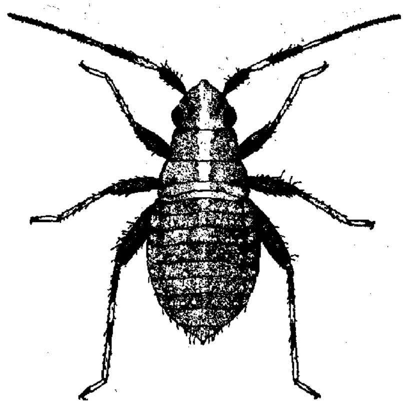

Fig. 31. *Paracalocoris hawleyi*, third stage nymph, × 17 (original).

reaching nearly to third abdominal segment; antennal segments thicker in red than in white areas. Dusky spot shows around gland between third and fourth abdominal segments. Aberrant specimens as before (Fig. 32).

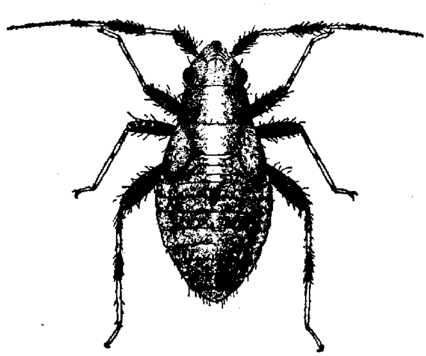

Fig. 32. *Paracalocoris hawleyi*, fourth stage nymph, × 13 (original).

Stage V: Length 4 mm. There is a wide variation in color; some light red with almost transparent wing pads; some dark red with wing pads and dark spots of legs sepia. Wing pads reach almost midway between fourth and fifth abdominal segments; dusky spot around gland more prominent; two dark spots may be present on

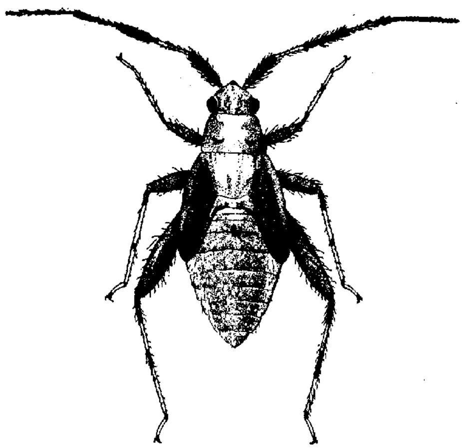

Fig. 33. *Paracalocoris hawleyi*, fifth stage nymph, × 10 (original).

pronotum. White spots around setæ very distinct. As in previous stages there is a wide variation in markings (Fig. 33).

The data on four specimens bred in the year 1915 are given in Table No. 1.

TABLE 1.—TRANSFORMATIONS AND LENGTH OF STAGES, 1915

No.	Egg Taken	Hatch	Stage II	Stage III	Stage IV	Stage V	Adult	Egg to Adult
1....................	May 21	June 13	June 19	June 21	June 30	July 8	July 14	31 days
2....................	May 21	June 13	June 19	June 21	June 30	July 6	July 13	30 days
3....................	May 6	June 15	June 20	June 24	June 30	July 6	July 13	28 days
4....................	May 6	June 10	June 15	June 22	June 30	July 7	July 12	32 days

Average; 30.1 days.

Breeding was carried on in petri dishes in a well ventilated, unheated field laboratory. Pieces of bark with eggs were placed in the dishes. These were examined and after hatching fresh food was added each day.

ADULT.—The adult is about 6 mm. in length, fusco-piceous to piceous with hemelytra sordid hyaline or pale yellowish and cuneous reddish. Pubescence is sparse.

Technical descriptions of the species and four varieties are published in the December (1916) issue of the *Annals of the Entomological Society*

of America by W. L. McAtee who examined the material sent him by H. H. Knight. Of these four varieties, *Paracalocoris hawleyi* var. *hawleyi* and *P. hawleyi* var. *ancora* are the common forms on the hop. The former has a pale lateral stripe on the corium (Fig. 34), which is not present on the latter. *P. hawleyi* var. *ancora* is much more numerous than the other form (Fig. 35).

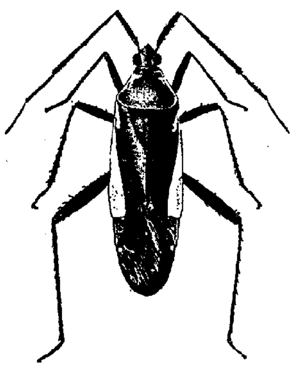

Fig. 34. *Paracalocoris hawleyi*, var. *hawleyi*, about × 7 (original).

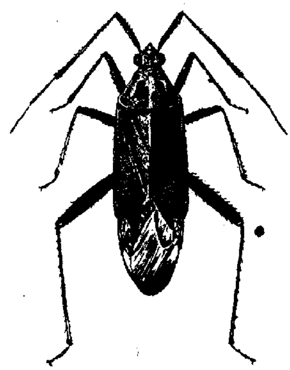

Fig. 35. *Paracalocoris hawleyi* var. *ancora*, about × 7 (original).

Habits

The nymphs are active and, when disturbed, crawl rapidly among the leaves and vines and into the cracks of the hop poles. At rest, they may usually be found on the under sides of the most tender leaves —often five to ten on a leaf and one hundred or more to a hill. When jarred, they drop straight down to a lower leaf to which they often adhere by everting the end of the alimentary canal. They prefer the tender leaves and vines and are, therefore, in August, more numerous near the tops of the poles.

The adult, when disturbed, drops a short distance and then flies gradually downward in a zig-zag course. At rest they may be found on the vines, poles, and on the upper and under surfaces of the leaves.

Seasonal History

Over-wintering eggs are laid in hop poles from the middle of August till September, as determined by dissected specimens. These hatch the following year from June 1 till nearly the first of July. The nymphal period lasts about thirty days, adults beginning to appear about the first of July. Nearly all are winged by the first of August.

Adults may often be found in September but eventually die. There is no evidence that they survive the winter.

Natural Enemies

Predators.—The Pentatomid, *Apeteticus maculiventris* Say, is predaceous in both the nymphal and adult forms on the immature stages of the hop redbug. Eggs and nymphs of this form are common on the hop in July and August.

One of the Nabidæ, *Reduviolus subcoleoptratus* Kirby, which is present on many plants near the hop yards, has been found feeding on the nymphs of the hop redbug.

A predaceous red mite (*Trombidium* sp.) has been observed on several nymphs.

The adults, *Paracalocoris hawleyi*, of this species have been found feeding on nymphs of their own kind. Nymphs have also been found feeding on the pupa of *Ania limbata* (Geometridæ), the larva of *Lysia cognataria* (Geometridæ), the larva of *Hypena humuli* (Noctuidæ), and the pupa of *Malacosoma americana* (Lasiocampidæ).

Control

In 1915 it was decided to test a tobacco extract spray on the hop redbug. To this end nicotine sulphate (Black leaf 40), 1 pint to 100 gallons of water, with 6 pounds of soap, was applied on July 17. The material apparently killed at once. However, as fifty-six live nymphs were found on six sprayed hills on July 19 another spray was applied. This time Black leaf 40, 1 pint to 100 gallons of water with 4 pounds of soap was used. On July 20, six hills had sixteen dead and eleven live nymphs present, but on July 21 no dead nymphs could be found. This is due to the fact that the nymphs, after the spray material dries, drop off. The following experiment shows that whenever nymphs are reached they are killed. On July 19, when field experiments were carried on, forty sprayed specimens were placed in a laboratory cage. None revived. Thirty specimens sprayed with an atomizer were all killed when the same solution as used in the field was applied.

Since nicotine sulphate, $\frac{3}{8}$ pint to 100 gallons of water with 4 pounds of soap, will control the hop aphis (*Phordon humuli* Schrank), the writer tried it to see the effect on the hop redbug. Leaves with redbugs from vines sprayed in the field were taken into the laboratory. Six of fifteen specimens were alive the following day. Seven of thirty redbugs sprayed in the laboratory were alive twenty-four hours later. When the bug became attached to the glass dish by means of the solution, it was invariably killed—otherwise it often recovered. To prevent sticking, filter paper was placed in the bottom of the dish and the

bugs were sprayed with an atomizer. Six of ten were killed. It is evident that this strength is insufficient for the control of the redbug.

To be successful, spraying should be done about the third week in June, before the vines have produced large arms. Most of the nymphs will have hatched and can be reached easily at this time. Later, when the vines become dense and many have slipped down the poles, it is impossible to reach all of the bugs hidden among the mass of leaves. Poles as well as vines should be drenched, as many nymphs take refuge in the cracks and under projecting bark. Because of the agility of the bugs, it is wise to spray a hill from opposite sides at the same time when possible. Winged forms fly before they can be reached by a spray.

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AMPHISCEPA BIVITTATA SAY, IN ITS RELATION TO CRANBERRY [1]

By H. B. Scammell, *Entomological Assistant, Deciduous Fruit Insect Investigations*

Introduction

The literature on this Fulgorid is somewhat barren in so far as the subject of its life history is concerned, and the following data are set forth as a contribution dealing chiefly with biological notes made in the course of the cranberry insect investigations being conducted by the Bureau of Entomology in New Jersey. Mr. H. K. Plank assisted the writer during two field seasons and to him he is indebted for making the photographs used in illustrating this paper.

The insect has been known as the "broad winged leaf-hopper" (1)[2] but that appellation scarcely is applicable because, at least on cranberry, it is not a pest of the foliage but of the woody stems, namely, the runners and uprights. The common name which is here suggested, inasmuch as the species is associated frequently with cranberry, a cultivated crop, is the cranberry vinehopper.

Economic Importance

Dr. John B. Smith (2) recorded *Amphiscepa bivittata* Say from several places in New Jersey and made a statement to the effect that it did

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[1] Published by permission of the Secretary of Agriculture.

[2] Reference is made by number to "Literature cited," page 556.

little injury to cranberry. That conclusion is fully supported by the observations of the writer, although the species is sometimes present in such large numbers on cranberry bogs as to warrant the growers in thinking that the bugs are mainly responsible for the sickly condition of their vines.

In the past four years the insect has been taken in every cranberry section of the state and, in every instance where it was found to be abundant, the vines were in an unthrifty or dying condition due primarily to other causes such as attacks of the cranberry rootworm (*Rhabdopterus picipes* Oliv.), the cranberry girdler (*Crambus hortuellus* Hüb.), or the blackhead fireworm (*Rhopobota vacciniana* Pack.). Vines weakened by conditions of drought were found to be susceptible to its attacks also. In all cases where the bogs were in a vigorous, productive state, the species was a rarity. It is, then, not of prime economic importance as a cranberry pest but essentially one of secondary classification.

Distribution and Food Plants

It is generally well known to collectors in this country, having been recorded from practically all sections, and among its previously reported food plants are cranberry, wild balsam, golden-rod and other weeds and herbage (3). The writer has bred the nymphs from egg punctures made in the wood of the swamp blueberry (*Vaccinium corymbosum*) and from cranberry.

Life History and Habits

One generation a year is produced, hibernation occurring in the egg stage either on winter flooded bogs or those not flooded at any time.

Egg

The egg (Plate 29, fig. A) is approximately pendant shape, one end being broadly rounded, the other more tapering and terminating in a white stalk or filament which branches halfway to its tip into two forks. The surface of the egg is marked with minute, regular hexagons. Color, pale straw. Size, length, without filament, .96 mm., width .384 mm. Place of deposition: the eggs are laid in live cranberry wood and, as frequently, in pieces of dead wood lying on the bog floor. They are always found in a single row, varying in number from one or a few to twenty or more in a single piece of wood. Each egg is inserted separate from its fellows into the pith of the upright or runner (Plate 29, fig. A), the opening in the wood being made by the female with two saw-like appendages of the ovipositor. The hole is closed with the sawdust produced in this operation and the outward indications that

eggs have been deposited in a bit of wood are the tufts of fibre (Plate 29, figs. B, C) which project above each egg slit. The egg lies in a slanting position with the filament projecting out to the bark.

Submergence of the eggs by flooding the bog from the usual time in December until late in the following May does not render them inviable. Late holding of the winter flowage, say until May 30, simply retards their hatching, the nymphs appearing early in June. On dry bogs hatching begins about the middle of May. At New Egypt, N. J., four nymphs of the first instar were found May 21 on a bog which had not been winter flowed.

Nymphal Stages

Nymphs first appear on the bogs in late May but are few in number until the latter part of June and early July. The usual spring reflows, then, cannot be depended upon to clear bogs of this insect since they are given at a time when very few nymphs have hatched. The nymphs of the first and second instars are almost wholly white, while those of later instars are darker in color and bear on the body many long, white, waxy filaments (Plate 29, figs. E, F). They run with considerable speed on the vines and are strong in jumping. Probably the easiest way to locate an infestation is by use of the sweepnet, many being caught by simply sweeping the tops of the vines. The majority, however, will be found closer to the ground or on the trash beneath the vines. They derive nourishment by sucking juices from the woody parts of the vines and yet they do not injure the vines to any appreciable extent as do the toadbugs (*Phylloscelis atra* Ger.).

There are five nymphal instars and, as shown in Table 1, the nymphal period may be prolonged from early summer until mid-fall.

Table 1.—Instars of Amphiscepa bivittata Say, Pemberton, N. J., 1914

Experiment Number	1	2	3	4	5
Date of 1st molt	June 6	June 7	June 9	June 9	June 10
Date of 2d molt	June 15	June 15	June 23	June 20	June 21
Date of 3d molt	June 26	June 27	July 6	June 30	June 30
Date of 4th molt	July 15	July 24	Aug. 9	July 13	Aug. 9
Adult emerged	Aug. 6	Died Aug. 8	Died Sept. 3	Aug. 5	Died Oct. 2

An average could be taken of the duration of each instar but it will be seen that the total nymphal period of each bug was a very variable quantity and probably was greatly influenced by condition of food and environment.

The field records show that nymphs were found on the bogs from May 21 until as late as October 11.

Adult Stage

The mature vinehopper is light green, approaching yellow, in general color, with brown face and two streaks of brown, extending from the face, along the edges of the thorax and prolonged on the inner margin of each fore wing. Occasionally a pink form is found. The fore wings are very large, appearing leaflike with their prominent network of veins, and are held vertically, giving the insect a flat-sided appearance (Plate 29, fig. D). They first appear on the bogs in early August, and by mid-August outnumber the nymphs. Bog collections have shown them to be abundant as late as October 10, with the date of latest capture as October 20.

Oviposition

The earliest field collection of eggs was made August 19, but egg laying was not common until the first week of September. In the process of oviposition the female rests on the upright with head downward and abdomen curved so as to place the posterior end at right angles to the upright. Several minutes are required to saw the egg slit and make the deposition, all observations being made in late afternoon.

Seasonal History

Stage	Period of Usual Occurrence	Range in Occurrence	Usual Duration
Egg...............................	Aug. 25–June 10	Aug. 19–June 20	9 months
Nymph (including pupal instar).......	June 1–Aug. 10	May 21–Oct. 11	1½ months
Adult...............................	Aug. 10–Oct. 1	July 27–Oct. 20	1½ months

Natural Enemies

In one of the wire screen breeding cages, stocked with thirty nymphs, a gradual diminishing in numbers took place and after a period of close watching, it was learned that a small spider had entrance to the cage and was carrying off the nymphs. Since the bogs are plentifully supplied with spiders they must be of considerable service in reducing the numbers of this species.

Some of the caged nymphs were found dead and covered with a white, fungous growth but this disease was never encountered in the field observations.

Control

Although the vinehoppers are, occasionally, abundant on some of the cranberry bogs, yet a careful study of the situation is practically

certain to reveal that the unthrifty condition of the vines, in these infested areas, is due primarily to some other agency. Such agency may be drought, unsuitable land for cranberry production, or the attack of other cranberry insects of well-known economic importance.

The remedy should, therefore, be directed at the removal of the greater pests, such as the fireworms, the cranberry girdler or the cranberry rootworm, if any of these are present, and, in general at improving conditions for growth of the vines by better cultural methods such as pruning, sanding and the application of commercial fertilizers.

If the bog can be reflowed during the summer the bugs may easily be exterminated by applying the water for twenty-four hours, preferably during a period of cloudy weather, about the 1st of August. All of the nymphs will have hatched at that time and no eggs of the new adults will have been laid. A slight wind will blow the bugs to one shore where they may be killed by the use of a kerosene burning spray torch.

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STUDIES ON THE MORPHOLOGY AND SUSCEPTIBILITY OF THE EGGS OF APHIS AVENÆ FAB., APHIS POMI DEGEER, AND APHIS SORBI KALT.

By Alvah Peterson, Ph. D., *Assistant Entomologist, New Jersey Agricultural Experiment Station*

A number of observations have been made on the structure and behavior of the outer coverings of the eggs of three species of aphides, *A. avenæ*, *A. pomi* and *A. sorbi*, found on apple trees. Some of the facts observed during the dormant period of the egg and at the time of hatching have an important bearing on certain control measures and these will be reported in brief with the expectancy of giving a more detailed account in the near future.

Explanation of Plate 29

Plate 1. *Amphiscepa bivittata* Say: A, Placement of the eggs in cranberry wood, X 7; B and C, Tufts of woody fibre above the egg punctures in cranberry wood, X 7; D, Adults on cranberry upright, X 6½; E, Pupal instar, X 7; F, Cast skin of 4th instar, X 7.


A
B
C
D
E
F

By careful dissection one can distinguish three layers about the embryo: an outer, semi-transparent, brittle (soft and glutinous when the egg is deposited) layer, an inner, pigmented (glossy black), elastic layer, and an innermost layer which is thin, transparent, and surrounds the young nymph as it emerges. At the time of hatching the outer brittle layer usually splits along the dorso-mesal line before the pigmented elastic layer is ruptured by the nymph. The time interval between the splitting of the outer layer and the severing of the inner pigmented layer apparently varies with the temperature. This may be two days under greenhouse conditions or eight days when the temperature registers 30° to 40° F. All details in respect to the behavior of the layers about the egg during the hatching period have not been observed, nevertheless, it is believed that the egg goes thru a critical change a few days (possibly several weeks) before the nymph emerges and that one important step during the hatching period is apparently the splitting of the outer layer a short time before the inner pigmented layer is ruptured.

In brief the observations on the morphological structure of the egg and the behavior of the respective coverings during the hatching period shows that the egg is not a hard resistant body and that it goes thru a critical change previous to the emergence of the nymph which undoubtedly means that it is not as resistant during these changes as in the dormant period. The susceptibility of the egg and its lowered resistance near the time of hatching are further substantiated by various experiments with differences in moisture and in the use of certain contact insecticides and other chemicals.

Various experiments with the eggs of all three species under constant temperature and different controlled moisture contents show that the outer brittle layer is somewhat impervious to water under ordinary atmospheric conditions and thus it acts as a protective layer to conserve the moisture content of the embryo. Under extreme dry conditions, the outer layer is not capable of indefinitely retarding evaporation, consequently the essential water content of the embryo is lost and the egg shrivels. The inner pigmented layer is membranous and does not conserve the water content of the embryo. This is conclusively demonstrated in one experiment where the outer layer was removed from a number of normal eggs and they shrivelled completely in twenty-four hours under ordinary atmospheric conditions. The innermost, thin, transparent skin about the embryo and young nymph as it emerges does not help to conserve the water content of the embryo, so far as known.

The percentage of hatch of the eggs of *A. avenæ* and *A. pomi*, under a constant temperature of 80° F., varies with the moisture content of

the air. A brief summary of a number of experiments shows that in dry air 0 to 4 per cent of the eggs hatched, in 22 per cent moisture 0 to 12 per cent hatched, in 63 per cent moisture 20 per cent hatched and in 100 per cent moisture 36 to 46 per cent hatched. This response of the eggs to differences in moisture indicates that drought or climates with low humidity probably have an important influence on the percentage of hatch. It has been recorded for Colorado that approximately only 1 per cent of the eggs of *A. pomi* hatch while the percentage of hatch for all three species at New Brunswick, N. J., ran about 25 per cent for *A. pomi* and *A. sorbi* (mixed together) and 50 per cent for *A. avenæ* and the relative humidity for New Jersey is higher than that of Colorado.

If the eggs are weak in structure and susceptible to differences in moisture, particularly during the hatching period and possibly a few weeks previous to this time, it would seem feasible to assume that certain contact insecticides and various chemicals should effect the egg during this period. This is unquestionably the case for a number of investigators using lime-sulphur at winter strength; crude oil emulsion and other sprays have met with success in killing the aphis in the egg stage when the spray was applied late in the season just before or as the buds were bursting.

The exact physical and chemical effect of the various sprays on the egg have never been explained and, so far as known, is still more or less a mystery. Very little is known concerning the chemical structure of the egg coverings or the nature of the reactions which may occur between the egg and the insecticide used, however, some of the physical effects produced by various substances have been noted and these are discussed briefly.

In order to kill the aphis in the egg stage, the material used must prevent the nymph from hatching or it may be of such a nature as to kill the nymph as it hatches. The preventive, from a physical standpoint, may act in several ways. Any substance which will harden the outer semi-transparent shell and thus make it impossible for the nymphs to emerge would be satisfactory. Lime-sulphur apparently hardens the outer covering, at least it was noted that a large number of treated eggs did not completely collapse and in many cases the outer layer retained its normal shape while the pigmented layer and the contents of the embryo within was completely shrivelled.

Any substance which will soften or dissolve the outer layer and thus expose the pervious, inner, pigmented layer to evaporating factors such as wind, heat or low humidity would make a satisfactory control. A weak solution of crude carbolic acid will soften and apparently disintegrate the outer shell. In one experiment, the eggs of *A. pomi*

were sprayed with a 2 per cent solution of crude carbolic acid plus enough laundry soap to break the surface tension of water and then placed in a moist chamber. In an hour or more after treatment the brittle outer layer was soft and wrinkled and could be easily removed. The general decidedly glossy black appearance of all eggs treated with crude carbolic acid in the various experiments and their manner of shriveling also indicated a disintegration of the outer brittle layer.

Furthermore many substances are splendid desiccating agents and any material possessing this quality might be able to extract the water content of the ovum or embryo and thus prevent further development. Lime-sulphur, so far as observed, seems to have some desiccating effect and possibly crude carbolic may likewise act in this way.

Any toxic substance which will penetrate the egg coverings and attack the living embryo would naturally be an important agent in control and probably more direct in its effect than the foregoing ways. The extent of this penetration by various substances is difficult to distinguish and as yet no technic has been found which might be used in determining this point.

Another possible means of control would be the discovery of some chemical which will loosen the egg from the twig and cause it to fall to the ground. There is some indication that sodium-hydroxide tends to produce this result.

The more important and common contact insecticides and various chemicals have been tried on the eggs of all three species, in the greenhouse with *A. avenæ*, out-of-doors at the laboratory with *A. avenæ*, *A. pomi* and *A. sorbi*, and in the orchard (lime-sulphur, nicotine sulphate and "scalecide" only) with *A. avenæ* and *A. sorbi*. In all cases some or all of the eggs are susceptible to any contact insecticide or other chemical used in the various experiments. Of the three species, *A. avenæ* is apparently more susceptible than *A. pomi* or *A. sorbi* to the various substances.

The following table gives a brief summary of a large series of experiments conducted with various insecticides and other chemicals. The percentage of kill is figured on the basis of considering the number of eggs hatched in the check as 100 per cent. If all the eggs were taken into consideration each of the following percentages would be closer to 100 per cent; an 80 per cent kill would be 90 per cent or even greater in the average experiment.

Material Used	Percentage Killed
Lime-sulphur, 1–8 or 1–9	85%–100%
Lime-sulphur, 1–8 plus "Black-leaf 40," 1–500	97%
"Black-leaf 40," 1–500 plus laundry soap, 2 lb. to 50 gal.	45%
Laundry Soap, "Fels Naphtha," 2 lb. to 50 gal.	5%– 33%
"Scalecide," 1–15	25%– 65%

MATERIAL USED	PERCENTAGE KILLED
"Mechling's Scale Oil," 1–19	79%– 90%
Sodium sulphocarbonate, 1–19	85%
Sodium chloride, 1 gram to 5 cc. water	26%– 35%
Sodium hydroxide, 2 pt. to 98 cc. water	85%– 95%
Crude carbolic acid (100%) 2 cc. to 98 cc. of solution plus soap 2 lb. to 50 gal. water	93%–100%

This representative series of results show conclusively that the eggs are susceptible to various insecticides, particularly lime-sulphur and lime-sulphur combined with nicotine. They are also susceptible to various chemicals not generally used as insecticides.

Orchard experiments with lime-sulphur, 1–9, and lime-sulphur, 1–9, combined with "Black-leaf 40," 1–500, gave good results in killing eggs of *A. avenæ* and *A. sorbi* when the spray was applied as the buds started to swell, March 31 to April 7. "Scalecide," 1–15, applied at the same time did not give a satisfactory control for the rosy aphis.

Carbolic acid and substances possessing phenol derivatives give some promise of becoming important agents in the control of aphis in the egg stage. So far as observed, crude carbolic acid in strengths up to 5 per cent acid will not injure young or old apple trees in a dormant condition. Six trees, young and old, were sprayed with a 2 per cent and a 5 per cent solution of crude carbolic plus enough laundry soap to break the surface tension of water and no injury could be found.

The greater percentage of kill with "Mechling's Scale Oil," when compared with "Scalecide," is believed to be due to the presence of phenol derivatives in the former and not due to differences in specific gravity because the two oils are practically identical in this respect. In brief, miscible oils possessing phenol derivatives give a greater percentage of kill, and this increase in kill is in all probability due to the phenol or cresols.

Scientific Notes

New Tick Records for Minnesota. In December, 1915, a male *Ornithodoros talaje* was sent to this office from Le Sueur, Minn. It had been found in the shop of a glazier in that town. The only source from which the tick could have come was hay in which it was stated glass had come packed from Oklahoma. The shop was upstairs in a flat roofed building, with no attic. No birds, bats or other animals were there. In April, 1916, a second specimen was sent in from the same source. This tick has been reported formerly from Florida, Texas and California.

A new tick has become established in Minnesota, *i. e.*, *Dermacentor albipictus*. Elk brought two or three years ago from Montana and placed in the game reserve at Itasca Park have been badly bothered with these ticks ever since their arrival. They became so bad this last spring as to require spraying of the animals. It is supposed that they were brought here with the elk as they have never previously been found in Minnesota.

C. W. HOWARD.

A Suggestion for the Destruction of Cockroaches. The recent successful attempts to destroy bedbugs in dwelling houses by superheating makes the possibility of killing cockroaches (*Blatella germanica*) by the same system seem feasible. A number of experiments have been carried out by the writer to ascertain what degrees of heat were fatal to them. It was found that temperatures below 120° F. were variable in their effect, but exposure to a temperature of 122° F. to 140° F. for twenty minutes destroyed 100 per cent. Many difficulties are involved in employing this method, owing to the habit of the cockroach of hiding in cracks, between walls, etc.

On the other hand cold is also very destructive to the "Croton Bug." We find that exposure to 24° F. for three hours killed 100 per cent, to 18° F. for twenty minutes killed 100 per cent, 10° F. for five minutes killed 100 per cent, to 0° F. for five to ten minutes killed 100 per cent. The application of cold for this purpose would meet with more difficulties than would that of heat.

The writer has not yet had the opportunity to make a practical test based on these observations, but offers the suggestion for what it may be worth.

C. W. Howard, *University Farm, St. Paul, Minnesota.*

27 September, 1917.

Occurrence of a Fungus-Growing Ant in Louisiana.[1] The presence of the fungus-growing ant, *Atta texana* Buckley, in Louisiana was first brought to the writer's attention on November 8, 1914. This was at Glenmora, Rapides Parish, in the long-leaf pine hills about twenty-five miles south-southeast of Alexandria. Specimens were collected and the identification afterwards verified by Dr. W. M. Wheeler. Farmers in the parish have more recently complained of injury to cultivated crops by the ant.

The species has hitherto apparently been recorded only from Texas. The following extract from a letter from a correspondent in Glenmora indicates that they have been present in that section for a long time. The correctness of the tradition which he mentions is, however, as Doctor Wheeler has stated in a letter to the writer, rather doubtful because of the improbability of queens, without which the species could not become established—being so transported. The correspondent writes as follows:—"There is an old tradition to the effect that the Spaniards brought them to this country from Texas. The old trail leading from San Augustine, via Natchitoches, to New Orleans passed through this country, and these ants may be found on most of the high sandy land on each side of this trail."

Thomas H. Jones, *Entomological Assistant,*
Bureau of Entomology, U. S. Dept. of Agriculture.

Some Sunflower Insects. *Weevil Attacks.*—Mrs. Cockerell noticed last September that weevil larvæ (*Desmoris*) were able to induce growth in unfertilized seeds. Bagged sunflower heads which were not fertilized produced no seeds, as the plant is not fertile with its own pollen. The ovaries shrink and show no development, but in one such head eleven ovaries contained weevil larvæ, and in spite of lack of fertilization were large and swollen, larger than the normal seeds. We are reminded of the experiments of Loeb, in which unfertilized eggs were caused to develop by various stimuli.

Systena hudsonias Forst, (det. Schwarz) was found eating leaves of *Helianthus annuus* at Boulder, July 22, 1915.

Autographa biloba Steph. has been bred from leaves of *Helianthus* at Montreal (Winn in litt.).

[1]Approved by the Secretary of Agriculture.

Loxostege coloradensis G. & R. (det. McDunnough) was bred at Boulder, Sept. 12, from a larva folding leaves of *H. annuus*. The larva is very pale yellowish, with a narrow greenish-grey dorsal band and a broad dilute grey band on each side; the tubercles are conspicuous and jet-black, each with one long hair. Head clear pale reddish.

T. D. A. Cockerell.

Asphondylia websteri n. sp. The occurrence of a European species in an isolated area in the southwestern United States appeared remarkable, though prior to the rearing of a large series of this fly by Mr V. L. Wildermuth at Tempe, Arizona, in 1917 it was impossible to more than question the earlier identification of this insect as the European *A. miki* Wachtl. The American form is a decidedly smaller, darker and more naked species. The general characteristics of the insect have been admirably given in the below cited circular by Professor Webster, to whom we take pleasure in dedicating this species.

Male: Length 2.25 mm. Antennæ nearly as long as the body, practically naked, dark brown; 14 segments, the fourth cylindric, with a length about six times its diameter and moderately stout, low circumfili. Palpi; first segment short, subquadrate, the second with a length over four times its diameter, the third a little shorter than the second, narrowly oval. Eyes large, black. Mesonotum dark reddish brown, practically naked, there being only a few short, sparse, yellowish scales and no well marked submedian lines. Scutellum reddish brown, postscutellum yellowish brown. Abdomen mostly a dark slaty brown, the genitalia reddish brown. Wings hyaline, almost naked, costa a light strawy brown. Halteres mostly pale yellowish, slightly fuscous subapically. Coxæ dark reddish brown. Femora, tibiæ and tarsi mostly a pale yellowish brown, the tarsi slightly darker. Genitalia; basal clasp segment short, stout, terminal clasp segment very short, stout, irregularly and strongly bidentate. Dorsal plate long, broad, broadly and triangularly emarginate, the divergent lobes narrowly rounded. Ventral plate shorter, deeply and roundly emarginate, the short heavy lobes obliquely truncate. Style moderately long, stout, narrowly round apically.

Female: Length 2.25 mm. Antennæ about ¾ the length of the body, practically naked, dark brown, the fourth segment with a length about six times its diameter, the fifth with a length about five times its diameter, the twelfth and thirteenth segments each with a length about equal the diameter, the fourteenth reduced, cuboidal. Palpi; first segment short, quadrate, the second with a length fully twice its diameter, the third about twice the length of the second, more slender. Mesonotum shining dark brown with a very few short, yellowish hairs. Scutellum yellowish, postscutellum yellowish orange. Abdomen a shining dark brown, reddish brown apically. Coxæ dark brown, legs mostly a strawy brown. Claws rather long, somewhat slender, the pulvilli shorter than the claws. Ovipositor when extended nearly as long as the thorax and abdomen. The dorsal lobes well developed. Other characteristics practically as in the male. Type Cecid. a2420.

1912 Webster, F. M. The Alfalfa Gall Midge, U. S. Dept. Agri., Bur. Ent., circ. 147, p. 1–4 (*A. miki* Coq. not Wachtl.)
1913 Morrill, A. W. Econ. Ent. Journ. 6:194 (*A. miki* Coq. not Wachtl.)

E. P. Felt.

The Indian Meal Moth, Plodia interpunctella Hubn., in Candy and Notes on Its Life-History. During January of this year there was brought from San Francisco to the Parasitology Laboratory of the University of California a quantity of chocolate-coated marshmallow candy thoroughly infested with the larvæ of *Plodia*. The candy was badly "worm eaten" and soiled with webs and castings. The manufacturer reported considerable damage done to candy stored in fancy pasteboard boxes. Evidently the eggs of the moth had been deposited on the candy either just before packing or before the paper boxes were closed.

A number of the moths were reared from the larvæ, and several life-history experiments were undertaken.

The moths were liberated in a screened cage in which a small quantity of candy was exposed. The cage was then placed in an artificially heated insectary with temperature ranging from 22° to 26° C. Egg deposition took place at night, and the minute, glistening whitish eggs, not over twelve to fifteen per female for the cases observed, were deposited in haphazard fashion directly on the candy near the under side of each piece. The individual pieces of candy rested in fancy paper cups. The incubation period was about forty-eight hours.

The very tiny larvæ soon ate small pits in the candy and gradually became hidden within a cavern. While growth was very rapid it was found necessary to cease observations before the entire larval period was finished. By comparison with younger larvæ collected from the originally infested candy and putting the beginning and final observations on the two groups together, it becomes evident that the active feeding period probably requires not less than four weeks.

Accurate observations on the original larvæ show that the fully grown individuals leave the candy and crawl into corners or crevices where they pass a prepupal period of from nine to twelve days, during which time they spin a crude web in which pupation takes place. The pupal period requires from ten to fourteen days under the temperature conditions above noted. On the other hand the pupal period requires from twenty-four to twenty-eight days under room temperature varying from 15° to 19° C.

Thus it will be seen that the life-history of *Plodia interpunctella* requires about forty days for its completion in a maintained temperature of from 23° to 26° C., and that this insect may be of considerable importance to the candy maker.

Wm. B. Herms,
University of California.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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There is need of a new term to characterize the present day economic entomologist and at the same time give the public a more adequate idea of what economic entomology really is. It is well known that entomology relates to insect life and the man on the street is possibly willing to concede that a practical or economic entomologist gives more attention to destructive pests without admitting that the work of the latter really amounts to much. It is too often taken for granted that entomology means a frivolous mania for collecting specimens or a devotion to the more abstract phases of the science that can be satisfied with nothing less than tabulating the number and variety of hairs or scales upon an insect's legs. Both are interesting and have their place, though there is little in common between such pursuits and some of the larger problems of applied entomology now being prosecuted in various parts of the country or demanding the attention of full-sized men.

Some years ago one of our colleagues became obsessed with the idea that it was practical to rid a state of mosquitos. He did not live to see the full realization of his hopes. His faith has been amply justified by subsequent developments. It was something more than the world recognizes as practical or economic entomology. A small weevil invaded the cotton fields of the South, causing great losses and threatening grave disaster. Field investigations in the very forefront of the invasion changed extensive losses to efficient control and in working out the larger aspects of this problem, we have much not ordinarily

comprehended under economic entomology. There was a similar invasion of New England by a pest bringing death and destruction to much of the best timber, and here again a study of the broader aspects of the problem resulted in satisfactory control by methods not commonly associated with the term economic entomologist.

Fundamentally, these are engineering problems, Entomological Engineering, if you please, and we believe that the more general use of some such term would assist materially in giving this branch of natural science the standing it richly deserves. Entomological Engineer would be no misnomer, since Webster defines engineering as: "The science and art of utilizing the forces and materials of nature." We have forest engineers, why not entomological engineers? These larger phases of natural history are becoming more insistent in their demand for solution and they can be handled only as adequate provision is made. The stake is larger and the issues more vital under the compelling necessity of war. Are we to meet the situation? Can we rise to our opportunities and demonstrate as never before the possibilities of knowledge directed to the control of injurious and dangerous insects?

The establishment of an absolute quarantine against the importation of all plants, more especially nursery stock, appears like an easy and effective method of preventing the further introduction of injurious insects and plant diseases. The experiences of this country would certainly justify such action in sections of the world where the native fauna and flora had been disturbed to only a very slight extent by the introduction of species with their enemies and diseases. This does not necessarily follow in the case of a country in close touch with other parts of the world and which has been importing large amounts of stock annually for a series of years. We already have many of the more important enemies of standard fruits, like the apple, and the adoption of such drastic measures should be preceded by a careful weighing of the benefits and losses consequent upon such action. It might be possible to exempt cosmopolitan plants, especially those in regions where they have been grown and shipped for years, and thus secure maximum benefit and minimum interference with commerce. It is the novelties, the less widely distributed plants, which are potentially the more dangerous, and these might well be brought in under governmental agencies charged with the employment of every reasonable precaution to prevent the introduction of dangerous insects and plant diseases. It may not be easy to distinguish between the two classes of plants and yet an absolute quarantine would be farther than many Americans would care to go.

Current Notes

Conducted by the Associate Editor

The cotton boll weevil has recently been found in Beaufort County, South Carolina, by Prof. A. F. Conradi.

Mr. H. H. Knight, investigator in entomology, Cornell University, is about to enter the United States military service, Aviation Corps.

Mr. J. W. Bailey, Bureau of Entomology, formerly located at Tempe, Ariz., has resigned from the service to accept other work.

Mr. Clarence R. Cleveland, assistant, has been promoted to instructor in economic entomology at the New Hampshire Agricultural College and Station, Durham, N. H.

Mr. Allan H. Jennings of the Bureau of Entomology has been commissioned a first lieutenant in the Sanitary Corps of the United States Army.

Under the Food Production Act, the Secretary of Agriculture has authorized the appointment of six additional men in the Bureau of Entomology for extension work in beekeeping.

Miss Margaret L. Moles, a post-graduate student at Cornell University, has been appointed insect delineator in the Bureau of Entomology to fill the vacancy caused by the death of Mr. J. F. Strauss.

Dr. W. J. Holland is chairman of the committee on arrangements for the coming meeting of the American Association for the Advancement of Science, to be held at Pittsburgh, Pa., December 28 to January 2.

Prof. Edwin C. VanDyke of the University of California, a specialist on the Coleoptera, and Prof. J. Chester Bradley of Cornell University, a specialist on the Hymenoptera, have exchanged work for the present college year.

The Federal Horticultural Board announced a public hearing at Washington on November 20, regarding a proposed quarantine to prohibit the importation of sweet potatoes and yams, on account of sweet potato weevils, *Cylas* spp., and the sweet potato scarab, *Euscepes batatæ*.

Mr. M. E. Kimsey, formerly deputy state entomologist of Indiana, has accepted the position of special field agent in the Bureau of Entomology, Cereal and Forage Crop insect Extension work, under the immediate supervision of Dr. A. W. Morrill, state entomologist of Arizona.

Messrs. Dwight Isely and H. C. Ingerson, Bureau of Entomology, have recently completed an insect survey trip in the orchard section of Arkansas, Missouri and Kansas. This trip was made in connection with the recently established laboratory for deciduous fruit insect investigations at Bentonville, Ark.

The following transfers have been made in the Bureau of Entomology: H. L. Dozier, Tempe, Ariz., to Charlottesville, Va.; C. C. Hill, Knoxville, Tenn., to Carlisle, Pa.; J. R. Horton to Wellington, Kans.; A. B. Champlain, Washington, D. C., to Lyme, Conn.; A. D. Borden to Upland, Cal.

The Food Production Act passed by Congress appropriates $441,000 for combating insect pests and plant diseases and the conservation and utilization of plant products. A portion of this has been allotted to the Bureau of Entomology for extension work in the various states.

In Idaho the legislature, at its last session, made appropriations to the University and Station, including $4,000 for the further study of insect pests troublesome to alfalfa and clover seed producers, and $1,200 for emergency calls in the investigation of plant diseases, insect pests and soil troubles.

A conference was called for November 12 and 13 at Pittsburgh, Pa., of the Committee on the Suppression of the Pine Blister Rust in North America. The meeting was held in the rooms of the Chamber of Commerce, and special attention was given to proposed legislation to prohibit the importation of plant materials.

The Florida Entomological Society, organized less than two years ago, now has sixty-one members and publishes a quarterly journal called *The Florida Buggist*, two numbers of which have appeared, one on June 21, and the other on September 21. The editorial staff is as follows: editor, Prof. J. R. Watson; associate editor, Dr. E. W. Berger; business manager, K. E. Bragdon.

The following appointments have recently been made in the Bureau of Entomology: G. H. Vansell, assigned to Tempe, Ariz. For extension work—Scott Johnson, A. L. Ford, Kansas; M. E. Kimsey, Arizona; H. H. Fort, Missouri; C. W. Curtin, C. F. Stiles, C. H. Gable, at large; J. M. Robinson, O. L. Snap, E. P. Barrios, G. Garb, S. W. Frost, H. N. Gellert, H. K. Laramore, H. J. Ryan, F. D. Young and William R. Martin.

Mr. J. L. E. Lauderdale, formerly of the United States Bureau of Entomology, stationed at Baton Rouge, La., is now located at Yuma, Ariz., as field assistant entomologist, and Mr. D. C. George, formerly of the Washington State College, has also been added to the staff of the Commission of Agriculture and Horticulture as plant pathologist, under the administrative supervision of Dr. A. W. Morrill, state entomologist.

Mr. M. A. Yothers, formerly assistant professor of entomology in the Washington Agricultural College, has been appointed to the position of specialist in apple insect investigations, Bureau of Entomology, and will undertake a thorough-going study of the codling moth and other orchard pests in the Rogue River Valley, Oregon, in coöperation with the Oregon Agricultural Experiment Station.

An entomological section has just been formed in the Lorquin Natural History Club of Los Angeles, Cal. The first meeting was held at the public library on September 15, at which fourteen were present. Dr. J. A. Comstock was elected chairman, and Mr. Raoul M. May, secretary. The section meets at the public library in the evening of the third Saturday of each month and all entomologists are invited to attend the meetings.

Mr. E. R. Sasscer, Bureau of Entomology, reports that the Florida fern worm (*Callopistria floridensis*) has recently appeared on species of *Adiantum* in a greenhouse in St. Joseph, Mo., and to date has practically ruined three crops of ferns when they were ready for marketing. This pest was in all probability introduced into Missouri in a shipment of ferns received from New Orleans, La., last spring. The Florida fern worm is gradually being distributed from state to state on ferns, and for the past two years it has been responsible for considerable injury to these plants in Anacostia, D. C.

On September 14 a conference was called by Dr. L. O. Howard at Riverton, N. J., to carefully investigate the present status of the recently introduced Japanese beetle, *Popillia japonica*. Those in attendance at the conference were: Dr. L. O. Howard, Prof. J. G. Sanders, Dr. T. J. Headlee, H. B. Weiss, E. R. Sasscer, William O. Ellis

and Dr. A. L. Quaintance. It was found that the beetle had established itself over an area of some 500 or 600 acres, being quite abundant in certain parts of this area. Thorough-going life history work is under way under the immediate direction of Mr. William O. Ellis, in coöperation with the New Jersey Agricultural Experiment Station. Special effort will be made to confine the insect to its present area of distribution and eradication measures will be undertaken if further study of the insect indicates such action as at all likely to be effective.

On October 4, a conference of southern entomologists was held at New Orleans to discuss the pink bollworm situation. It was attended by W. E. Hinds, Alabama; Franklin Sherman, Jr., North Carolina; E. L. Worsham, Georgia; Wilmon Newell, Florida; E. E. Scholl and E. L. Ayers of the Texas Department of Agriculture; Prof. S. W. Bilsing of the Texas A. and M. College; W. R. Dodson, director of the Louisiana Experiment Station; B. R. Coad, Tallulah, La.; T. E. Holloway and W. D. Hunter of the Bureau of Entomology. After a full discussion a resolution was passed to the effect that unless further infestation is found at some point in Texas it is unnecessary for any of the southern states to modify their present quarantine regulations or promulgate new ones.

Mr. F. C. Craighead, Bureau of Entomology, spent the first two weeks of September in the vicinity of Kansas City, Mo., and Colorado Springs, Col. In the former locality he investigated the cause of the dying oaks. A large percentage of the oaks in that locality (reported generally also through the state) is dying slowly from year to year. The insect associated with these dying trees, and no doubt responsible for the death in a large measure, is the two-lined chestnut borer (*Agrilus bilineatus*). The beetles attack the top, killing this in one or two seasons and frequently kill the entire tree. At Colorado Springs, Mr. Graighead studied the work carried on at the station for the past two years in the control of poplar borers (*Saperda calcarata* and *Xylotrechus obliteratus*). At higher elevations entire stands of poplars have been destroyed by these insects.

Mr. R. S. Woglum, Bureau of Entomology, reports that on September 17 a man was killed at Upland, Cal., by liquid hydrocyanic acid while making preparations to fumigate citrus trees. The accident was due either to some defect in the apparatus or possibly to carelessness. This seems to be the first fatality which has occurred in some thirty years of orchard fumigation in California. Anhydrous liquid hydrocyanic acid for fumigation purposes was apparently first employed by Charles W. Mally in South Africa in 1915 and was subsequently investigated by private concerns in Southern California. As the result of these investigations, considerable interest has been awakened among California growers and fumigators, and at the present time a number of outfits are using this method of fumigation. Just what effect the unfortunate fatality referred to above will have on this method of fumigation in California is problematical. It may result in the return to the pot or machine method of generation. While it may be that the use of liquid hydrocyanic acid has advantages over the method of fumigation standardized by Mr. Woglum, it must be remembered that its practical value can only be established by a thorough investigation by those familiar with the subject, and commercial work should not be undertaken by those unacquainted with the poisonous nature of liquid hydrocyanic acid which volatilizes with great rapidity. A thorough investigation of this subject by Mr. Harry D. Young, who is a chemist as well as a practical fumigator, is now in progress under the direction of Mr. Woglum.

Mailed December 15, 1917

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